Water

P.E.I.'s MOST PRECIOUS RESOURCE

GROUNDWATER RESOURCES EVALUATION

MONTAGUE

THE CANADA – PRINCE EDWARD ISLAND
WATER MANAGEMENT AGREEMENT

Environment Canada Environnement Canada

Prince Edward Island
Department of the Environment

GROUNDWATER RESOURCES EVALUATION

MONTAGUE

92-07480/

Groundwater Resources Evaluation - Montague

Executive Summary

A review of the available hydrogeological data for the Montague area was conducted during 1989 and 1990 to document the current status of groundwater resources in the community. The results of this investigation indicate that the current demands for water are adequately met by existing on-site servicing, with regards to water quantity, and that concerns over water quality are more likely to be an issue in the future.

Analysis of existing pump test data indicates that wells developed in the fractured sandstone aquifer underlying the community are capable of yielding relatively high flow rates, sufficient to meet any likely residential, commercial or industrial demands in the foreseeable future. Hydraulic gradients generally are high and locally would be expected to be reflected by high groundwater velocities. While these circumstances, when combined with relatively permeable overburden, may render the area fairly susceptible to groundwater contamination, they may also result in relatively short residence times and rapid dilution of contaminants.

Natural water quality in the area is generally very good and principle water quality concerns relate to contamination by leaking petroleum storage tanks, locally elevated chloride levels and the more isolated occurrence of elevated nitrate concentrations. While representing a less tangible threat to water quality, the level of development in the community and the resulting high density of wells and potential sources contamination may be expected to lead to further degradation of groundwater quality over time.

There are several areas in close proximity to the Town which could be exploited as a source for a central water supply if at some point the community determines that the development of such a supply is prudent. Any such development should be accompanied by appropriate well field protection measures to ensure the long term integrity of the supply. The implementation of some form of land use restrictions in areas with potential for water supply development would help ensure that options for future supply remain open. A heightened awareness of water quality issues will be important components of the wise management of the Town's groundwater resources.

Acknowledgments

This study was completed as a part of the Canada - P.E.I. Water Management Agreement, a joint initiative of Environment Canada and the Prince Edward Island Department of the Environment. The author wishes to acknowledge the efforts of Don Carey of Jaques, Whitford and Associates, who oversaw the compilation of much of the information upon which this study was based. Thanks go also to the many staff of the P.E.I. Department of the Environment for the many stimulating and fruitful discussions on various aspects of this work. Particular gratitude is expressed to Paul Baker for his able support in various office and field activities during the preparation of this work. The patient review of this manuscript, and guidance through various phases of this work by Rory Francis, P.E.I. Department of the Environment and John Gibb, Environment Canada is gratefully appreciated.

Groundwater Resource Evaluation - Montague

Table of Contents

	Executive Summary		i
	Acknowledgments		ii
	Table of Contents		1
1.	Introduction		2
2.	Geography.....		2
3.	Geology		
	3.1	Surficial Geology	3
	3.2	Bedrock Geology	4
4.	Hydrogeology		
	4.1	Existing Well Data	4
	4.2	Pump Testing, Aquifer Characteristics.	8
	4.3	Groundwater Flow Regime	13
5.	Groundwater Quality		
	5.1	Baseline Groundwater Quality	15
	5.2	History of Water Quality Problems	17
	5.3	Potential Threats to Water Quality....	19
6.	Planning Considerations		
	6.1	Availability of Water.....	21
	6.2	Groundwater Protection strategies....	24
7.	Conclusions and Recommendations		29
	References.....		31

Appendices:

I	Well Data	33
II	Water Quality Data	51

1. Introduction

This report documents the findings of a study of the groundwater resources of the Town of Montague, conducted as part of the Groundwater Resource Evaluation Project, under the Canada - Prince Edward Island Water Management Agreement. The purpose of the this project is to investigate, through a series of studies, the available groundwater resources in selected communities across the Island and to make recommendations regarding the most appropriate manner of developing and protecting this resource, in light of the physical constraints and expected water needs of each community.

2. Geography

2.1 Physical Geography

Montague is located at the eastern end of Prince Edward Island, 50 km from Charlottetown. The topography is gently undulating to hilly, with slopes generally towards the Montague River, except where the slopes are toward the creek which forms the northern boundary of the community. The slopes toward the Montague River are steeper on the southern side of the river. Highest elevations occur on the southern side of the river, near the southern boundary and the Wood Island Road at 39m. The community covers an area of 233 ha. There are few low lying swampy areas, except along the creek and river.

2.2 Cultural Geography

The Town of Montague is the largest centre in the southern portion of Kings County with a population of 1994 according to the 1986 Census. Primary industries, some light manufacturing and service industries account for the majority of economic activity in the area.

3. Geology

3.1 Surficial Geology

Overburden in the Montague area is quite varied. A band of loose stoney to bouldery sand till ablation moraine borders the Montague River on the south side (Prest, 1973). South of this deposit, overburden consists of sand phase till ground moraine. A wide band of glaciofluvial kame terrace deposits, consisting of well to poorly sorted sand, gravel and boulders abuts the

river on the north side. Inland from these materials, overburden consists of clay - sand phase till ground moraine. From the stratigraphic logs on the Well Drillers Reports, overburden thickness averages 6.7m.

The soil survey report (MacDougal and Veer, 1981), indicates predominantly Alberry series soils, which are coarse and moderately coarse (less than 8% clay) textured, strongly acid ground moraine on undulating to rolling topography, with good surface drainage, rapid to moderate subsoil permeability and deep water tables.

3.2 Bedrock Geology

Bedrock consists of Lower Permian sedimentary strata of Megacyclic Sequence IV (van de Poll, 1981). These consist predominantly of red conglomerate, and sandstone, generally becoming coarser with depth, with basal conglomerate overlying disconformably the sandstone and siltstone of Megacyclic Sequence III. Well drillers reports indicate predominantly sandstone with some siltstone and claystone.

4. Hydrogeology

4.1 Existing well data

The Prince Edward Island Department of the Environment has well drillers reports for approximately 270 wells drilled in the community of Montague since 1970.

Average well depth in the community is 27.4 m with a maximum depth of 122 m for one well drilled for the Department of Community and Cultural Affairs. With the exception of a few other deep wells (60 m+ for the hospital, high-school and other institutional establishments), most domestic wells do not exceed 30 m in depth. Casing lengths average 11 m, with a minimum of 3 m and a maximum reported length of 63 m.

Static water levels in the community vary considerably, reflecting in part the considerable topographic relief compared with some other parts of the province. Some of this variation in static water levels is probably only apparent, as some of the static water level data is somewhat suspect. In particular, there are locations where the reported static water levels are below sea level. Since this is most unlikely, it is probable that the measurements were made before the water level in the wells had fully recovered after bailing or yield testing of the wells.

In addition, since the wells were drilled during different times of the year, over a twenty year period, both seasonal and annual variations in the water table elevation is reflected in this data. Data from a continuously monitored well elsewhere in the watershed (Caledonia) indicate that seasonal variations in water level as great as 5.2 m. may be expected, particularly in areas of higher relief.

The average well yield as reported in the well drillers reports is 0.8 litres per second (L/sec.) with a minimum of 0.08 L/sec. and a maximum of 11 L/sec. Included in these reports are three deep wells (122 m) drilled by the Dept. of Community and Cultural Affairs, near the Langley Packers Plant, each with a reported yield of 11 L/sec. In addition to these there are three production wells at this site, one of which is reported to be capable of yielding 36 L/sec., although at the time the well was constructed, it was recommended that this well be pumped at no more than 22 L/sec. due to concerns over saltwater intrusion. (subsequent experience in the area suggests that these concerns may have been unwarranted.) Most domestic wells or other more shallow wells in the region do not yield in excess of 4 L/sec.

To make more meaningful the well yield data from the well drillers reports the well depth, or more precisely the saturated portion of the aquifer penetrated by individual wells must be taken into account. As is common on P.E.I., individual aquifers are often difficult to identify especially as the flow of water through fractures is probably more significant than primary porosity in determining hydraulic conductivity. (Francis, 1989). For these reasons the entire saturated thickness of sediments penetrated by well can be approximated as a single semi - confined aquifer. All other factors being equal, a deeper well with a greater depth of open hole below the water table would be expected to yield a greater quantity of water than a shallower well. To evaluate the water yielding characteristics of the aquifer then, it is useful to take into account the saturated thickness (water bearing portion) of each well when considering well yield.

As a measure of well yield, the yield per metre of saturated thickness penetrated, for each well has been calculated. Figure 1 shows the frequency distribution of well yields per metre of saturated thickness for the community as a whole. The data has also been separated into two groups; the north west portion of the community north of the river , and the south eastern portion south of the river. In spite of differences in topography, little difference is apparent in the water yielding characteristics of the aquifer from this data.

North of the river, the average yield per metre of saturated thickness (in litres per second per metre of saturated thickness (L/sec./ m) is 0.07 L/sec/m, ranging from a minimum of 0.0015 L/sec/m to a maximum of 0.7 L/sec/m. South of the river the range of values was somewhat lower, but the average value was also 0.07 L/sec/m, with a minimum value of 0.023 L/sec/m and a maximum value of 0.33 L/sec/m. This would mean that on average, a well with 12 m of saturated thickness (the lower 12 m of the borehole filled with water) would be expected to be capable of yielding approximately 0.76 L/sec.

Data from the well drillers reports were also examined for any correlation between well yield (again measured as yield per foot of saturated aquifer thickness) and well depth and static water level. Figures 2 and 3 show the relationship between yield per saturated thickness and

Figure 1

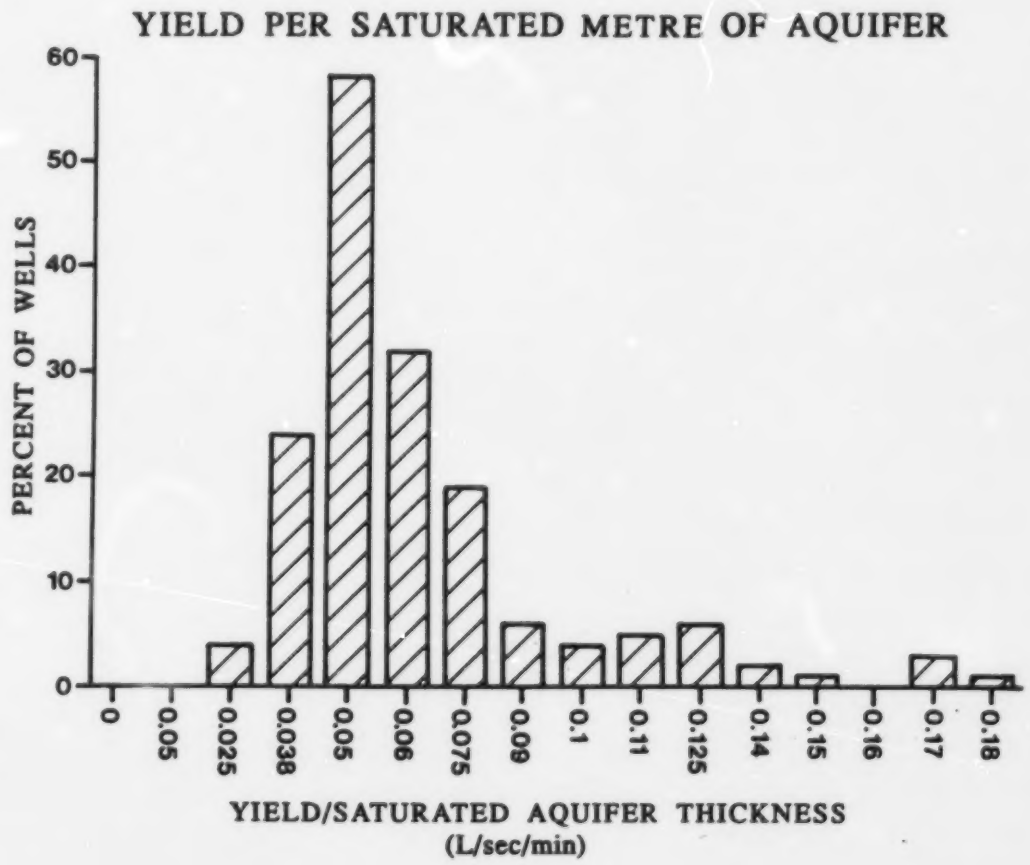

YIELD PER SATURATED METRE OF AQUIFER
PERCENT OF WELLS
60
50
40
30
20
10
0
0
0.05
0.025
0.038
0.05
0.06
0.075
0.09
0.1
0.11
0.125
0.14
0.15
0.16
0.17
0.18
YIELD/SATURATED AQUIFER THICKNESS
(L/sec/min)

Figure 2

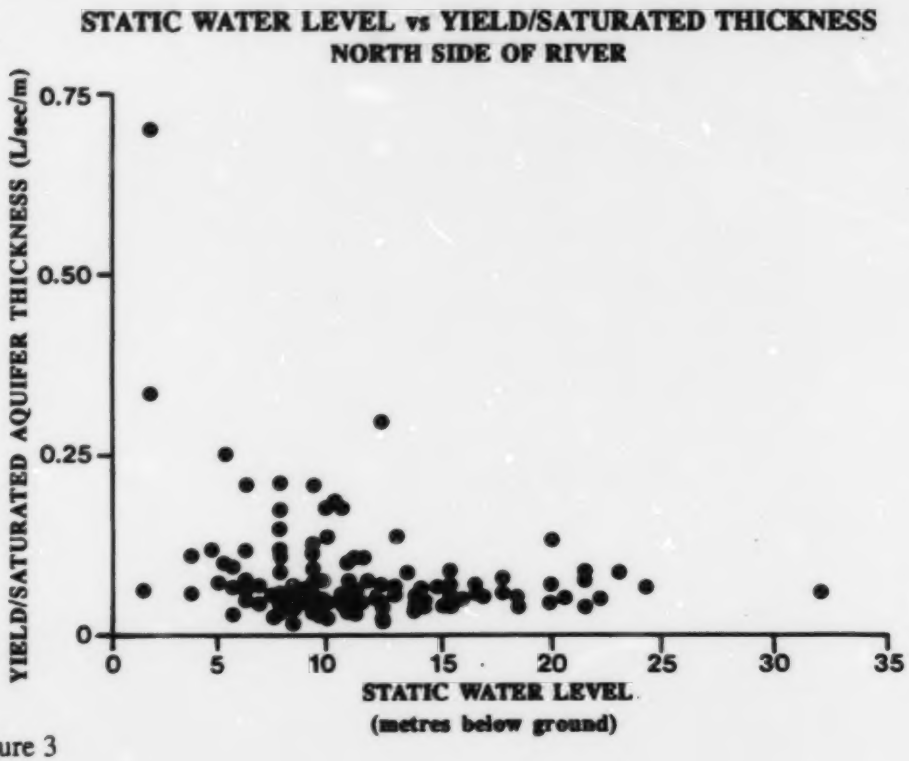


Figure 3

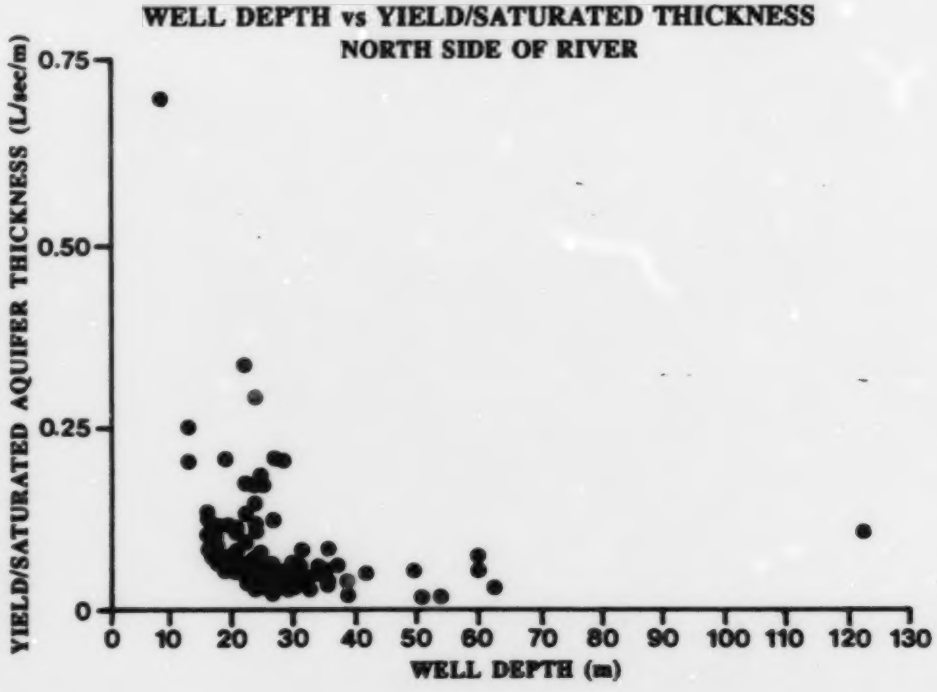


Figure 4

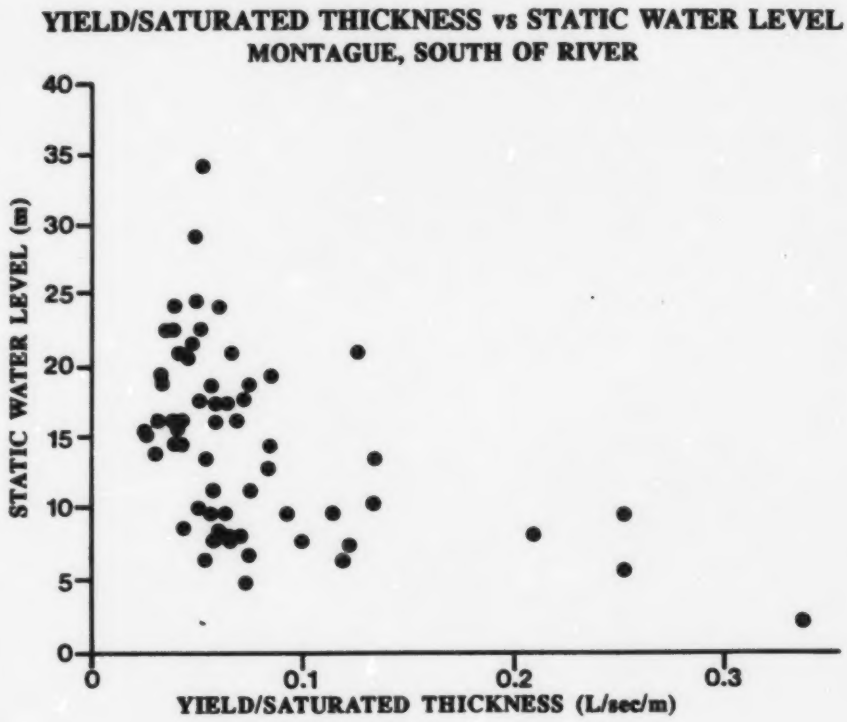
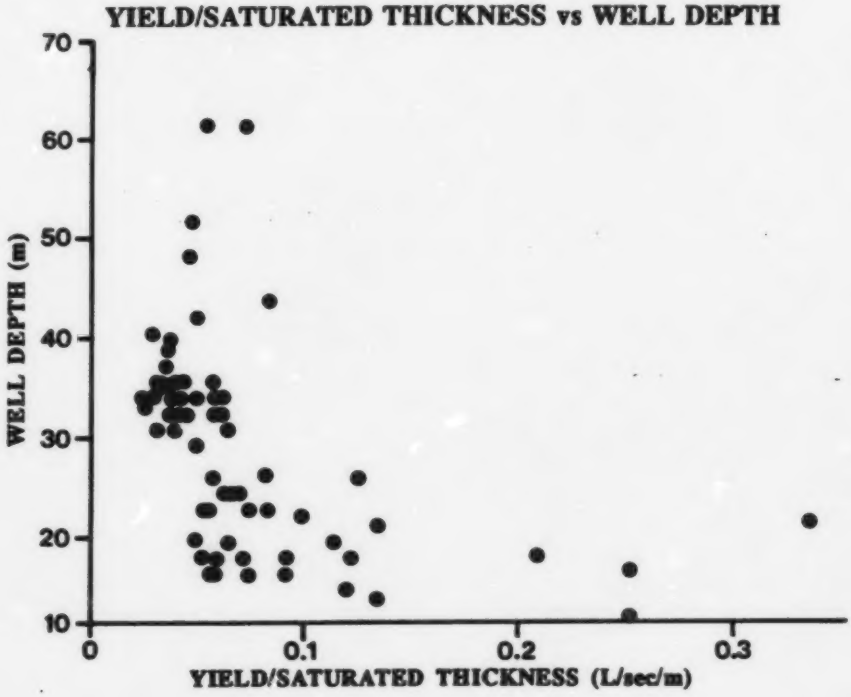


Figure 5



static water level and well depth respectively for the north side of the river while figures 4 and 5 show the same information for the south side of the river. Again results from both the north and south side of the river were similar. In general, higher well yields tend to be in areas where static water levels are high. In addition, on average the higher yield per saturated thicknesses seem to be associated with shallower wells.

These features probably reflect the fact that the most productive portions of the aquifers typically found on Prince Edward Island are found at shallow depths, where fracture frequency and aperture size are greatest. Because the bulk of water movement is through fractures not intergranular flow in a fractured porous media such as these aquifers, it is the distribution of these fractures which play the most significant role in well yield. In lower lying areas with higher static water levels, a greater portion of the shallow more highly fractured part of the aquifer is saturated. The negative correlation between well depth and yield per saturated thickness indicates a diminishing return in well yield with increasing well depth.

4.2 Pump Testing, Aquifer Characteristics

In addition to a relatively extensive data base of well information, Montague is fortunate in having been the site of a number of more detailed hydrogeological investigations, including several pump tests of varying duration and sophistication. Because the availability of pump test data, no additional test drilling or pump testing was carried out as part of this study. Described below, are the results of pump tests conducted at four sites in the Montague area. Table 1 summarizes the aquifer parameters determined from these tests.

Langley Packers Site

In 1965, a relatively extensive hydrogeological investigation was carried out, just east of the Town of Montague at the site of Langley Packers. Three existing wells at the plant were simultaneously subjected to a 72 hour pump test, and two additional wells were constructed and subjected to 24 hour pump tests. The location of the wells are indicated on Figure 6. The study concluded that while wells #1, #2, and #3 could sustain pumping rates of 36.2, 21.2 and 25.7 L/sec. respectively, concerns over the potential for saltwater intrusion from the Montague River, would make pumping rates of 22 L/sec. for well #1 and 11 L/sec. for well #2 & #3 are advisable. (As noted earlier, these concerns may have been unwarranted.) Wells A & B on the figure were each tested at rates of 11 L/sec.

From the pump testing at this location, a number of aquifer characteristics can be determined. Values for transmissibility (denoted "T", this value represents the relative ease with which water can move through the aquifer) are relatively high compared to many other areas on the Island with an average value of 213 m^2/day. A storativity value (the amount of water released by the aquifer per unit decline in head) for the area is less certain due to reported well losses

and inhomogeneties in the aquifer. Analysis of the data from the 24 hour tests conducted on well "A" and "B" suggest a value in the range of 3.95×10^{-4}, which is within the normal range found on the Island.

Table 1

Site	Well	Q (L/sec)	T (m^2/d)	S	S.C. (L/sec/m)
Langley Packers	1	36.2	212	-	1.84
	2	21.2	240	-	0.99
	3	25.7	169	-	1.47
	A	11.4	233*	3.95x10-4	0.65
	B	11.4	52**		0.94
Montague Regional High School		4.2	185	2.4x10-4	0.87
Health Services Bldg.		3.8	58**	-	0.87
Sr. Citizens Home Unit 5		2.3	16**	-	0.22

Q = discharge rate of test, T = Transmissibility in m 2/day, S = Coefficient of Storativity, S.C. = Specific Capacity

* Transmissibility value depends on interpretation of test data, see text.
** Transmissibility calculated from pumping well data only

It should be noted that results from test well "A" and "B" should be viewed with some caution, as the pump test data indicate some unexplained changes or anomalies in the drawdown data recorded in the observation well. However the effects of this anomaly (sharply reduced drawdowns in the observation well after 7 hours of pumping) should if anything, cause an underestimate of the transmissibility. The value indicated on table 1 is based on the first 6 hours of data, and should provide a conservative estimate of T.

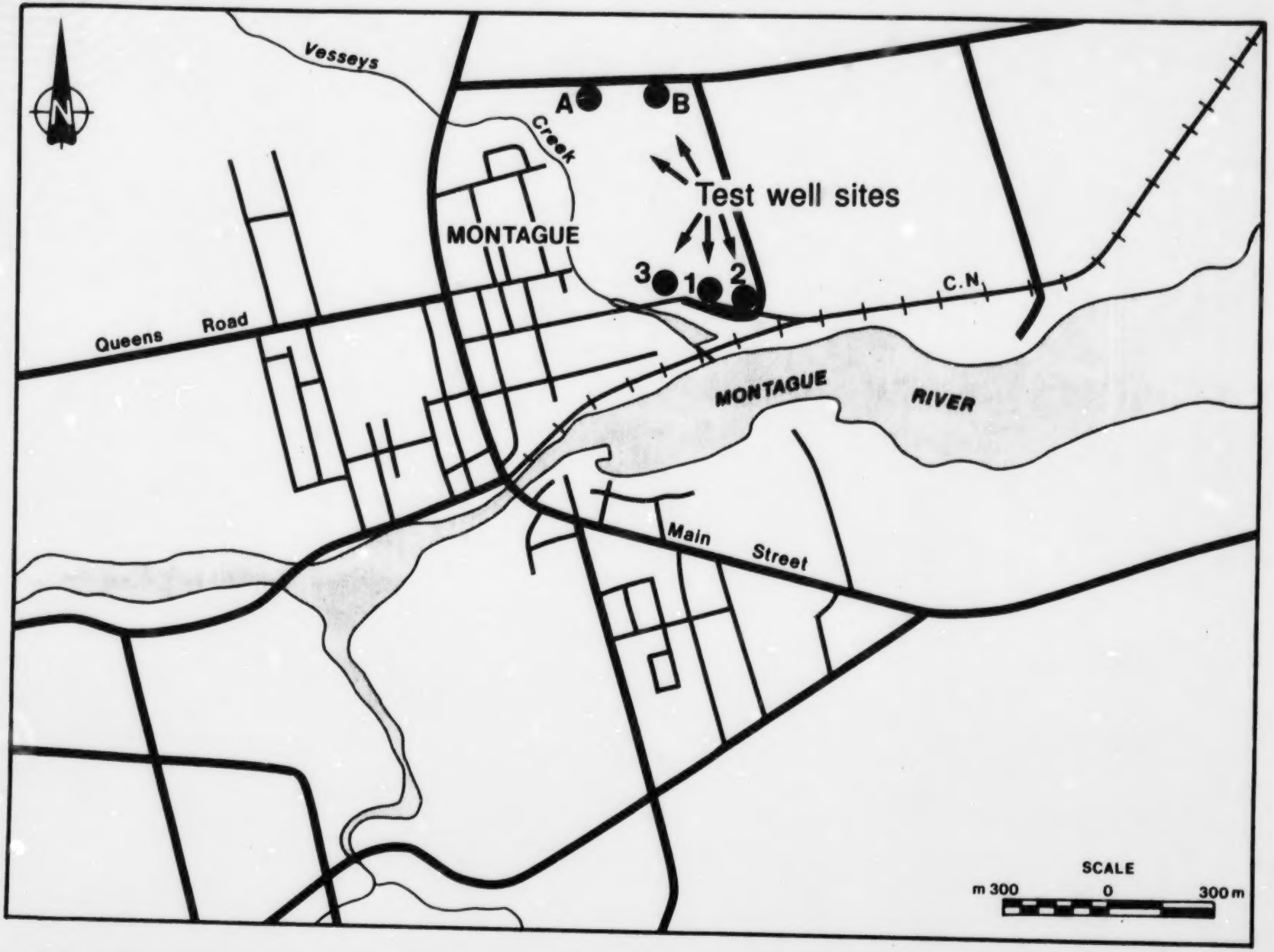

Vesseys
Creek
A
B
Test well sites
MONTAGUE
3
1
2
C.N.
Queens Road
MONTAGUE RIVER
Main Street
SCALE
m 300
0
300 m

Figure 6

Another feature to be noted is the fact that "T"values derived only from pumping well data show considerably lower values then those derived from observation well data. This is at least partly because the drawdown observed in the pumping well is a result of the combined influences of head losses due to turbulent flow in and around the well bore as well as a lowering water levels in the surrounding aquifer in general.

Other Pump Tests:

Shorter duration pump tests have also been conducted on wells at the Montague Regional High School, the provincial Health Services Building on the Douse's Road, and a senior citizens home in the north eastern part of the community. The testing at the Montague Regional High School indicated similar T and S values, although the pumping rate was substantially lower at 4.2 l/sec.

Testing at the Health Services Centre and the Senior Citizens Home did not include the measurement of water levels in observation wells during pumping, thus no estimate of "S" has been made. In addition, because of the effect of well losses on the resulting water levels in the pumping wells, "T" values are likely to be underestimated to some extent. Nonetheless, the "T" values derived from recovery data from the tests are somewhat lower than those represented from the Langley Packers site and the High School. It is not certain whether this difference is a function of the type of data analysis, or of the prevailing aquifer characteristics in these locations.

At the Health Services Centre, pumping rates as high as 4.9 L/sec. were sustained without a significant stress on the well (a total of 4.9 m of drawdown after 6 hours of pumping), and with a specific capacity of 0.87 at a pumping rate of 3.8 L/sec., it is likely that the well could yield a considerably greater amount of water. In fact the specific capacities during step drawdown test of this well increased with pumping rates, rather than the decline of specific capacity normally expected with increasing pumping rate. It is likely this is because the well was still developing during the test, underscoring the probability that this well may be capable of a considerably higher yield. Table 2 presents the data from the test, and Figure 7 shows the results graphically, as well as the predicted drawdown for the well under differing pumping rates based on the relationship $s = BQ + CQ^2$ (Robinson, 1986) where s is drawdown, and BQ and CQ^2 are coefficients representing laminar and turbulent components of drawdown respectively, and are determined from the pump test data.

Similarly, testing of the well at the High School indicates that the well is capable of producing considerably more water that the 4.2 L/sec. rate at which it was tested.

With the existing data it is difficult to comment in much detail about well performance or well efficiency. Data from a step drawdown test conducted on the well at the Health Services Centre actually showed a slight increase in specific capacity as the pumping rate was in

Figure 7

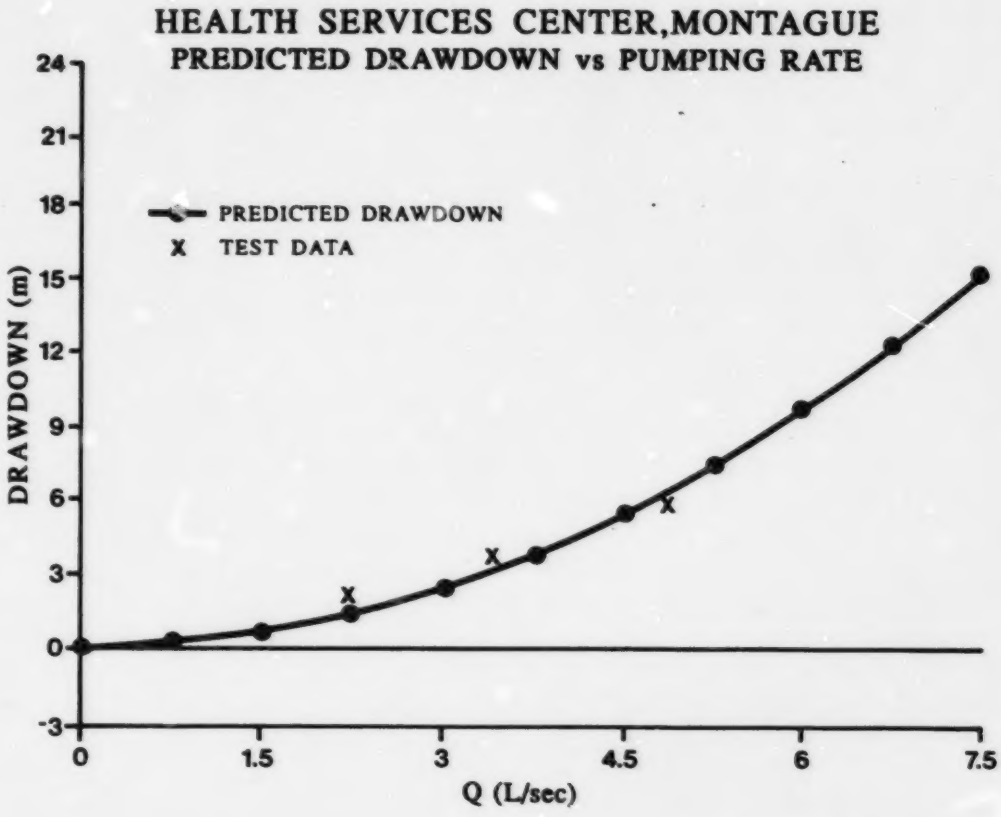


TABLE 1

STEP DRAWDOWN TEST
HEALTH SERVICES CENTER,MONTAGUE

STATIC WATER LEVEL=6.04 m

STEP	Q (L/sec)	WATER LEVEL (m)	DRAWDOWN (Δs)	SPECIFIC CAPACITY (Q/Δs)
1	2.250	8.72	2.68	0.84
2	3.375	9.32	3.28	1.03
3	4.875	9.93	3.89	1.25

creased. More frequently one would expect that specific capacity would decline with an increased pumping rate as well losses begin to make up a larger portion of overall head losses. In this case it is likely that the well was still developing during the test, and thus the efficiency appears to be greater at higher pumping rates.

A comparison of the actual drawdown of a pumping well with the water level which would be predicted based on "T" and "S" values for the aquifer, can give some insight into the relative importance of well losses in response to pumping. While there is only limited information on the storativity coefficient for the aquifer in the Montague area, data from the tests at Langley Packers and the High School can give some indication of typical well efficiencies in the area.

During a 24 hour constant rate test of test well "B" at the Langley Packers site, the drawdown in the pumping well was approximately 11 m. The predicted drawdown in this well, based on "T" and "S" values derived from the test values is about 4.9 m , thus the well has an efficiency of approximately 44% (or in other words slightly more than half of the drawdown in the well is presumed to be a result of head losses associated with turbulent flow in and around the well bore). Without observation well data, and a reliable estimate of the storativity coefficient in the vicinity the higher capacity wells at the Langley Packers site it is not possible to estimate the efficiency of these wells.

Similar calculations for the well at the Montague Regional High School indicate efficiencies in the range of 70%. Unfortunately similar calculations cannot be made for other higher capacity wells in the area, because of a lack of the necessary data, but the results do indicate that well losses in the Montague area are not as high as in some other parts of the province.

4.3 Groundwater Flow Regime

In spite of the abundance of well driller's reports for the Montague area it is difficult to compile a comprehensive picture of the groundwater flow regime from the existing data. The primary drawback of this data is uncertainty regarding the accuracy of the static water level data.

In spite of these difficulties, a somewhat schematic picture of the groundwater flow regime can be pieced together, which although not precise in detail, illustrates the general characteristics of groundwater flow in the area. Figure 8 shows the approximate water table elevations and groundwater flow directions in the community. While it has been attempted to base the groundwater elevation contours on actual well data, a significant amount of interpretation has been used to complete this figure. It should also be noted that the data from which the figure is derived are in English units, and no attempt was made to convert the data base to a metric format. Groundwater elevations are therefor presented in <u>feet</u> above mean sea level, not metres above mean sea level.

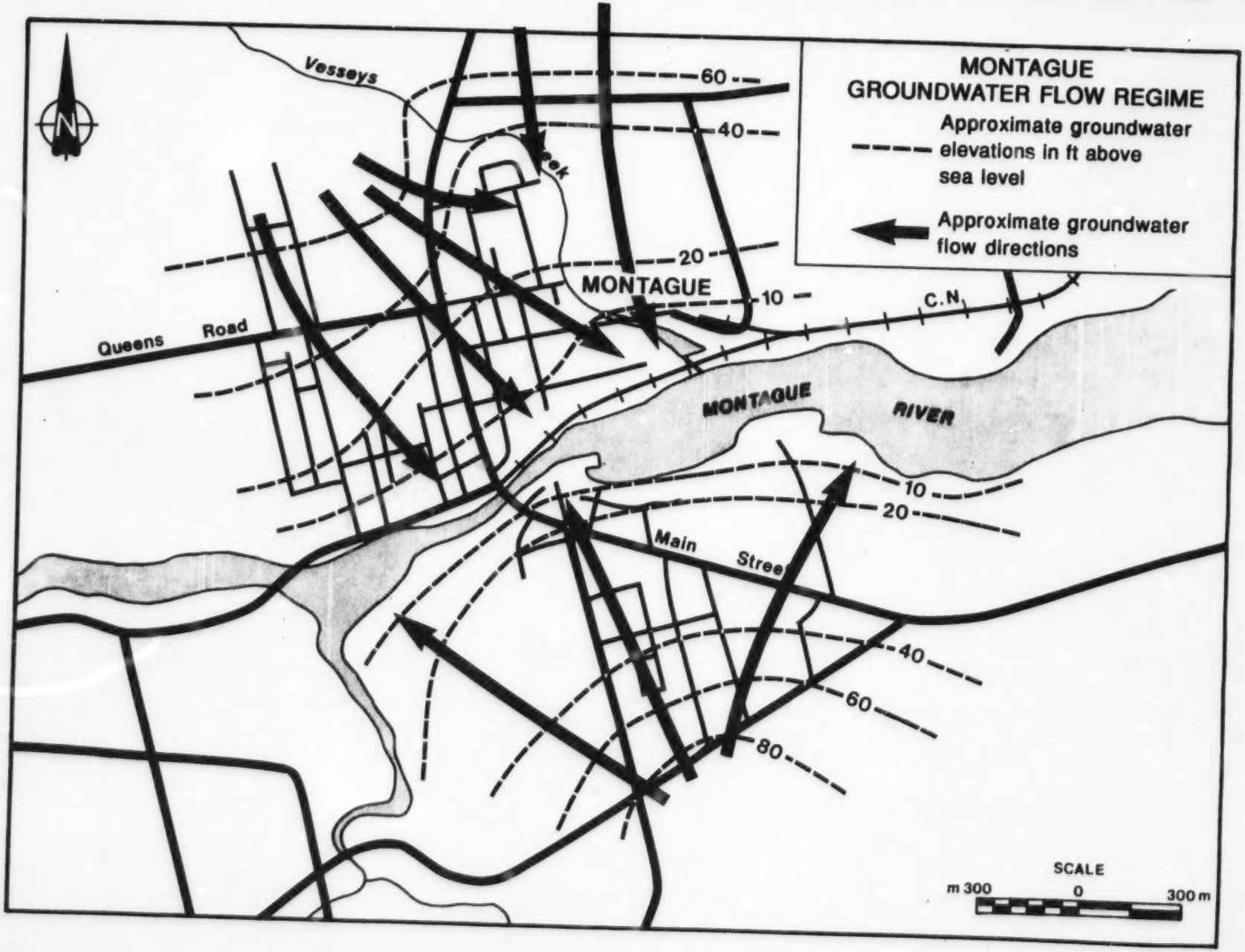

MONTAGUE
GROUNDWATER FLOW REGIME
Approximate groundwater elevations in ft above sea level
Approximate groundwater flow directions
N
Vesseys
60
40
20
10
MONTAGUE
C.N.
Queens Road
MONTAGUE RIVER
10
20
Main Stree
40
60
80
SCALE
m 300
0
300 m

Figure 8

The data suggests the existence of two discrete flow systems, one on either side of the Montague River, with flow from each system being from the surrounding higher ground on the sides of the river valley towards the river. On the north side of the river the hydraulic gradient averages about 2.5%, although on the lower ground near the river it may be as low as 1%. In contrast the hydraulic gradient appears to average 4.5% to 5% south of the river in areas of relatively high relief. Insufficient data exist to determine the average vertical hydraulic gradient in various locations in the community.

One of the implications of the relatively steep hydraulic gradients on the south side of the river is that groundwater flow velocities would be expected to be quite high. This has both positive and negative aspects. The rapid flow of groundwater means that potential contaminants could be expected to migrate significant distances in relatively short periods of time. On the other hand such rapid movement of groundwater will also mean that once damage is done to the aquifer, it may take less time for the aquifer to recover, as it is being "flushed" at a higher rate.

5. Water Quality

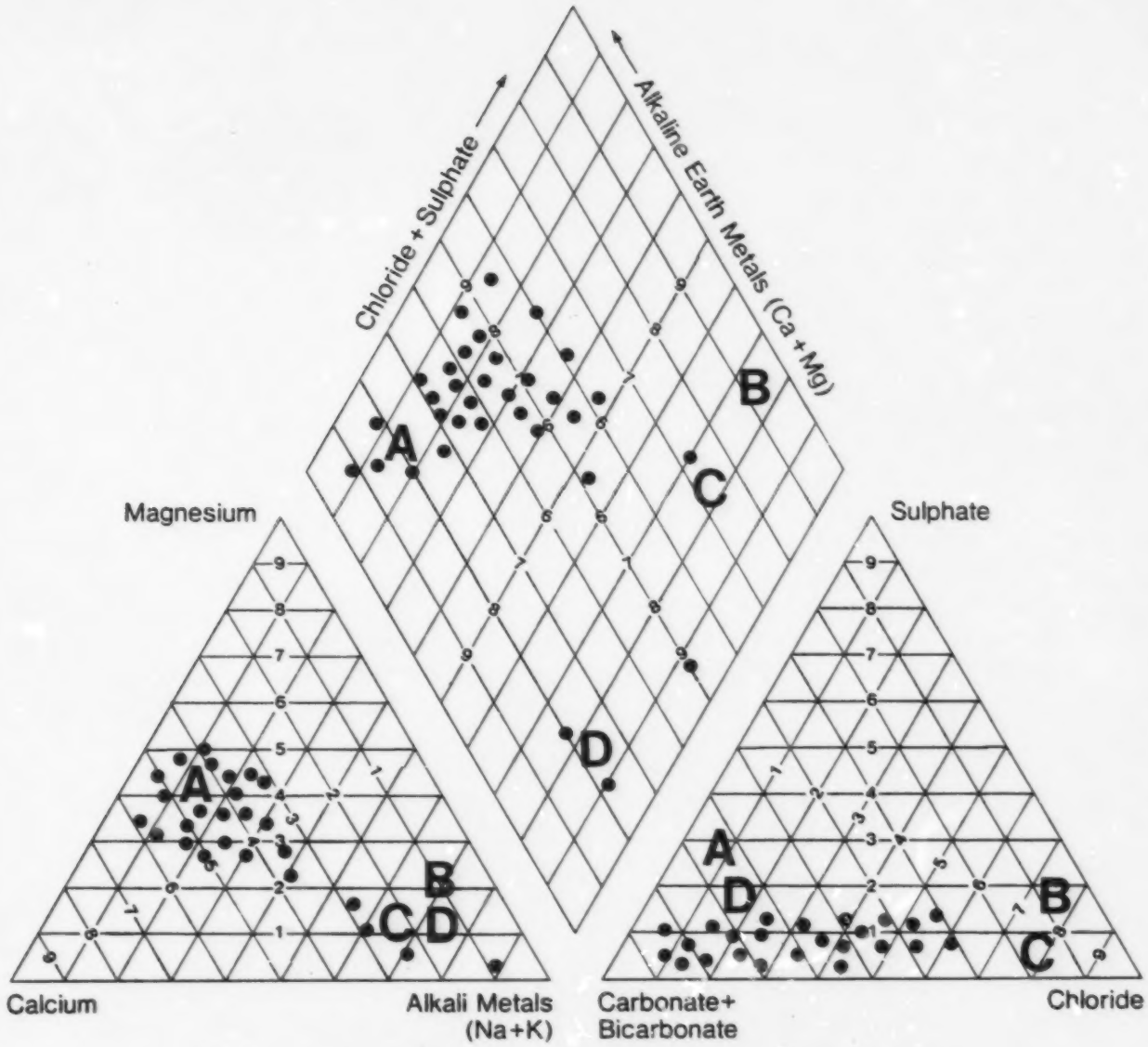
5.1 Baseline Water Quality

Generally, water in the Montague area is of a calcium-magnesium bicarbonate type, with hardnesses rarely less than 100 ml/L, (hard to very hard water). Other influences on baseline water quality in the area are limited occurrences of seawater intrusion and the more rare occurrence of naturally softened groundwater (sodium bicarbonate type water). Figure 9 shows the relative proportions of the major ions in selected groundwater samples from the community. The bulk of the analyses cluster around the field of "calcium-magnesium bicarbonate type" waters. For comparison, point A on the diagram indicates the average composition of water from the Charlottetown Water Commission, which is typical of groundwater compositions on the eastern and central portions of the Island.

Some of the results outline a trend towards more saline compositions (elevated chloride and sodium concentrations) further to the right on the diagram. For comparison, the relative concentration of the major ions in seawater is shown at point "B" on the diagram.

One of these points (a sample from a well at the Montague Dairy, point C on the diagram) what is likely to be the influence of sea water intrusion. Other points in this area of the diagram represent samples from locations far removed from the river, and are probably related to other sources of sodium and chloride, such as road salt storage or application. It should be noted however that even these elevated concentrations of sodium and chloride are far below those found in seawater, and except in extreme cases fall within the guideline values for drinking water set by Health and Welfare Canada.

Figure 9



MAJOR ION COMPOSITION OF GROUNDWATERS, MONTAGUE AREA

- • Domestic well, Montague
- **A** Charlottetown Water Commission
- **B** Sea water
- **C** Montague dairy
- **D** $Na\text{-}HCO_3$ type water

Finally a few analyses indicate naturally softened water with sodium and bicarbonate as the dominant ions, instead of the more frequent combination of calcium and magnesium and bicarbonate. This water is most likely representative of a natural softening process by which calcium ions in solution are exchanged for sodium ions on clay minerals in the aquifer after prolonged periods of contact. While examples of this water type are relatively rare in the Montague region, the occurrence of this water type has been noted at other locations on the Island, particularly at depths below those usually encountered for domestic wells. Point D on the diagram is representative of this type of water.

While the incidences of elevated chloride levels in areas removed from the river may not be a naturally occurring in a strict sense, over time, with a gradual continued degradation of water quality, these incidents may lose their site specific characteristics and be more properly considered to represent "baseline" or naturally occurring water quality.

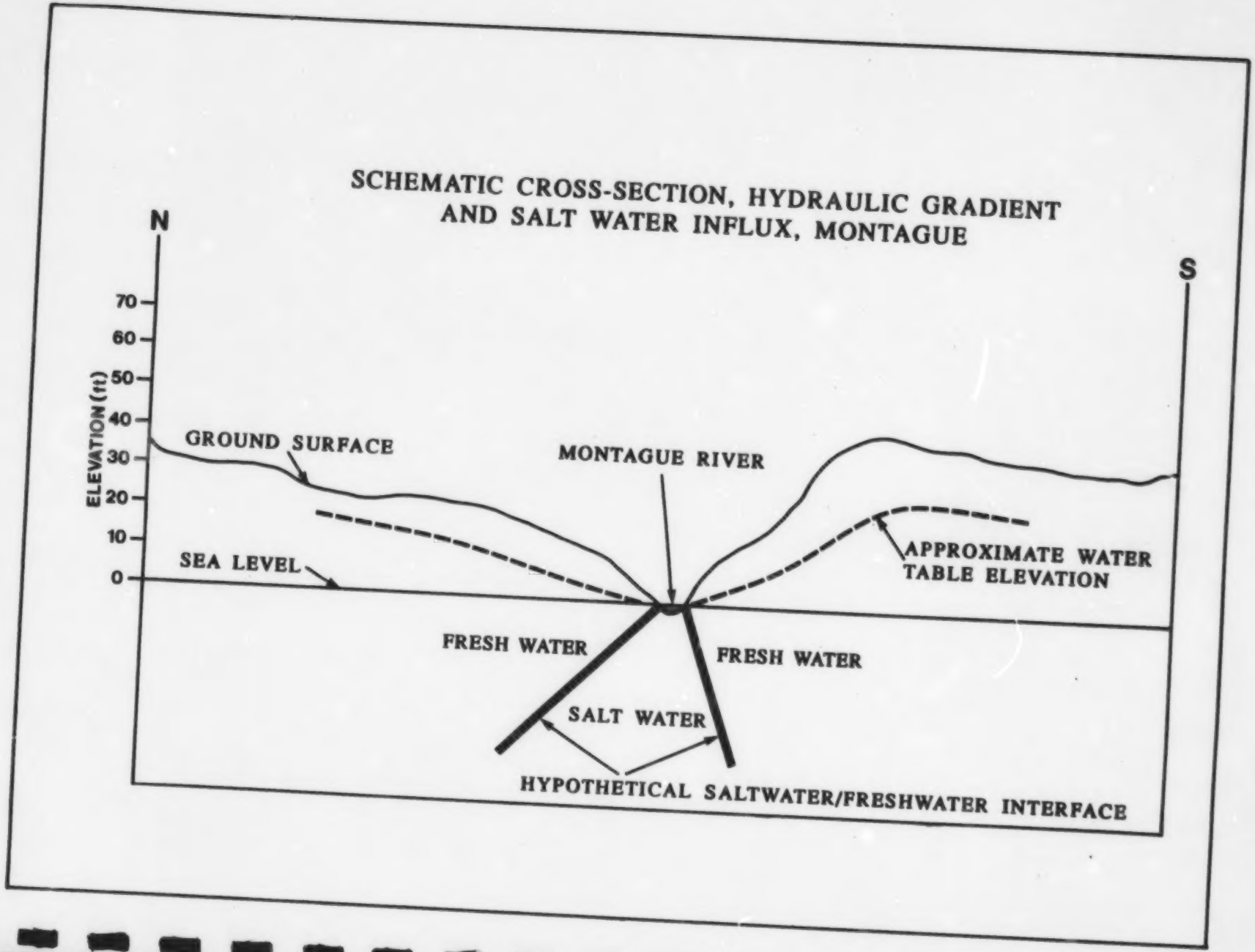
5.2 History of Water Quality Problems

Probably the most frequently reported water quality problem in the Montague area is the occurrence of elevated chloride levels. As noted above there are two probable sources of salt to which this problem can be attributed, saltwater intrusion from the Montague River, and the storage and/or application of road salt. In particular, sample results from the area near the Montague Dairy and near the sites of the old salt storage depot to the west of the Wood Islands Road and the present salt storage depot on Water Street have indicated high chloride levels.

In the case of the area near the Montague Dairy, it is probable that elevated chloride levels are due to salt water intrusion from the river. This is not surprising, considering the relatively low elevation of the area and expected low hydraulic gradient. Under these conditions it would be expected that the salt water / fresh water interface would be at relatively shallow depths compared to regions on the south side of the river, where elevations are higher and hydraulic gradients are steeper. Figure 10 schematically represents the relationship between topography, water table elevations and the position of the saltwater / fresh water interface as it might be expected in this area.

In the case of the two road salt storage areas, it is likely that elevated chloride levels are a result of leaching of road salt by precipitation, and subsequent infiltration to the water table, not the influence of saltwater intrusion. In the case of the abandoned salt storage depot on the Wood Islands Road, wells with high chloride levels tap portions of the aquifer well above sea level, and thus salt water intrusion can safely be ruled out as a source of salt.

Figure 10


SCHEMATIC CROSS-SECTION, HYDRAULIC GRADIENT
AND SALT WATER INFLUX, MONTAGUE
N
S
ELEVATION (ft)
70
60
50
40
30
20
10
0
GROUND SURFACE
MONTAGUE RIVER
SEA LEVEL
APPROXIMATE WATER
TABLE ELEVATION
FRESH WATER
FRESH WATER
SALT WATER
HYPOTHETICAL SALTWATER/FRESHWATER INTERFACE

At the present salt storage depot, two lines of evidence support a manmade source of salt. Test drilling at a site on High Street, during investigations in this area during early 1990, revealed salt contaminated groundwater to depths of approximately 21 m below ground level (chloride levels as high 310 mg/L). Below this level and fresh water was encountered. If saltwater intrusion was the source of the contamination, chloride levels would be expected to increase with depth not decrease. In addition, samples from nearby well on Water Street, owned by the Department of Fisheries and Oceans, indicate fresh water in spite of a location closer to the river and at a lower elevation.

It is probable that with the relatively steep hydraulic gradient towards the river in this area, the saltwater / freshwater interface is situated a depth in the aquifer not tapped by most domestic wells, as is indicated schematically on Figure 10.

In addition to these areas there are other more widely distributed areas where chloride concentrations may be somewhat elevated, but not sufficiently high to permit identification of a single obvious source. In these instances it is difficult to say whether the high chloride levels are the result of salt storage, or the application of road salt on roads. Certainly in areas of higher traffic or where there are steep hills, it would be reasonable to anticipate some effect of heavier than average applications of road salt on groundwater chemistry.

Following elevated chloride levels, contamination of groundwater by petroleum products is probably the next most serious threat to groundwater quality in the Town of Montague. Petroleum spills or leaks have occurred at a service station just north of the Town boundary, at the location of a former Texaco station on Main Street North and at the Montague Dairy. The spill at the service station north of the community has contaminated a number of domestic wells, as far away as Down East Crescent in the northeast part of the community. In addition there have been a number of smaller spills which do not appear to have had any more than localized effects on the surrounding area.

5.3 Potential Threats to Groundwater Quality

Probably the most common threat to groundwater quality on Prince Edward Island is contamination by petroleum products from leaking underground storage tanks. The Town of Montague has already been the site of a few of these incidents, and it is only realistic to expect that other spills will occur in the future. Therefore groundwater in the immediate vicinity around service stations or other locations where significant quantities of petroleum products are stored is probably at some risk of contamination. It is worth mentioning also that while large underground petroleum storage tanks perhaps pose a greater risk to groundwater resources when taken individually, because of their numbers, domestic home heating oil tanks have statistically account for a significant portion of contamination events.

It has been noted that the storage of road salt may be a contributing factor to elevated chloride levels in groundwater from some areas of the Town of Montague. It is more difficult to establish a link between high chloride levels and the application of road salt, however it can be expected that in areas of relatively heavy application such as high traffic or hilly areas, this application will have some effect on groundwater quality. The extent both laterally and vertically of such an effect may be difficult to determine, especially where such elevated levels may tend to gradually decrease towards "background" levels with depth or distance from the source of salt.

There a couple of areas in the community where past or present land use practices could lead to concerns over high nitrate concentrations. On the south side of the river, near the site of a former piggery nitrate levels tend to be slightly higher than average. This area is located south of Main Street (south) and east of MacDonald Ave although slightly higher than normal values have been recorded at Riverview Manor on the north side of Main Street. While most nitrate values are below the 10 mg/L limit outlined in the Canadian Water Quality Guidelines, a few analyses indicate levels slightly above this limit (maximum of 14 mg/L.).

While most incidences of elevated nitrate concentrations appear to be concentrated in the area referred to above, there is the potential for nitrate contamination of groundwater from any intensive livestock operation. From this perspective, another area of concern might be in the north west part of the community near the livestock operation just outside the town boundary on the Queens Road. To date analyses of water from this area do not show evidence of unusual levels of nitrate.

Other areas of potential concern include two dump sites, one at the present site of the GlenMar Trailer Park, and the other outside the town limits to the north east of the former Langley Packers site. The dump which was located at the GlenMar Trailer Park is a Priority I dump site containing household wastes. The dump near the Langley Packers site is a Priority II site with household, agricultural, and industrial wastes.

Pesticides and other potential organic contaminants do not appear to be a serious problem in Montague at this time. During the winter of 1990, a leaking pesticide container was discovered in the Thompson Poole Warehouse on Water Street. During investigations it was learned that a small quantity (it is believed that one gallon or less actually reached the ground) of the pesticide Dinoseb had leaked from a metal container and ran out of the building. Water samples from nearby wells showed no trace of Dinoseb.

Samples were also collected in the area around the former site of a pole yard operated by Maritime Electric. It had been reported that in the past, transformers which may have contained PCB bearing fluids had been temporarily stored at the site. Samples analyzed from the area showed no evidence of PCB's in the groundwater.

The community of Montague is serviced by a central sewer system, and problems with bacterial contamination of wells are relatively rare. There was one incidence where a senior citizen's home on the Wood Islands Road experienced bacterial problems for a period of a year. The problem was traced to a ruptured sewer line, and has since been corrected.

Finally, although posing only an indirect threat to water quality in the community, the very source of water itself (individual wells) may be as much a reason for concern as many of the more direct and obvious hazards affecting water quality. Because of the density of population in Montague, and the reliance almost exclusively on on - site water supplies, there is the likelihood that general water quality will gradually decline over time. Each well (particularly poorly constructed wells) represents a discreet pathway for water, and any potential contaminants it may carry, from the near surface environment to portions of the aquifer from which water supplies are developed. While the impact of each well individually, may be virtually negligible, cumulatively the influence of such a great density of wells will inevitably alter conditions in the subsurface environment including groundwater quality.

For these reasons it is particularly important to be vigilant over such issues of proper well construction, completion, and eventual abandonment in order to maintain as pristine and natural a subsurface environment as possible. Naturally, more obvious sources or incidences of contamination deserve even stricter attention.

6. Planning Considerations

6.1 Availability of Groundwater

A review of the available hydrogeological data indicates that sufficient quantities of groundwater are available to meet the current and expected future needs of the community, whether this water is provided by the existing on - site servicing (individual wells) or by a central water supply system. It is probable that water quality considerations will be the prime constraint in the development of water supplies in the Montague area in the future.

As noted above in the previous section, there a number of water quality problems in the Town of Montague, which although not overly threatening in immediate terms, do cause some concern for the future security of supply. Some of the more site specific problems may have relatively straight forward solutions. Other problems are more difficult to address, such as slight, but locally widespread elevation of chloride levels, or the general decline in water quality which can be expected to accompany the continued reliance on on-site water supplies in a relatively densely developed areas. One of the questions the community should address is "if" or "when" central servicing of the Town would be advisable. Furthermore it would be advisable to identify the existing groundwater resources which potentially could be available for future development, and how the resource can be protected.

With a population of just under 2,000, a supply of approximately 545 m^3/day or 6.4 L/sec (based on a consumption of 0.27 cubic metres per day per person) should meet present domestic and commercial requirements. This does not consider industrial water use or provision for fire protection which of course would increase demand. Peak flow requirements are likely to be about three times this amount or about 1635 m^3/day (19 L/sec.).

The data collected from production wells and test wells at the former Langley Packers site to the north east of the community could probably be counted on to supply close to 60 thousand cubic metres per day (68 L/sec.), more than three times the expected community requirements, exclusive of industrial demand. In addition, the current level of development and land use practices at this site would facilitate implementation of appropriate well field protection measures in this area. The main drawback of this site from a water supply perspective, is the relatively low elevation relative to some of the areas of the community which would require servicing.

There are a number of other areas in the Montague area which have potential for water supply development, including an area in the north west of the community, and two areas to the south of the river.

Pump test data from the well at the new Health Services building on Douse's Road indicate favorable aquifer conditions, with a specific capacity in the same range of some of the wells at the Langley Packers site. It was noted above that this well may be capable of a significantly greater yield than the 3.8 L/sec. it was tested at.

While it is always difficult to extrapolate results from one location to another, the relatively undeveloped land just to the south east of this area might prove to be a suitable location for water supply development. In addition, the area would be suitable for the implementation of well field protection measures, and is at an elevation that might make servicing of areas of the community on higher ground easier to service.

Other places which may show promise for water supply development but lack any pump testing data are the area on the south side of the river,to the north of the Valleyfield Road west of the Wood Islands Road and an area in the north eastern part of the community, north of Cambellton Street and MacIntyre Avenue. In the case of the area north of the Valleyfield Road, care would be needed to avoid relatively saline groundwater, contaminated by the former site of the road salt depot.

When considering any area for the development a water supply which will involve substantial groundwater withdrawals, it is important to ensure that the area under consideration can support the required level of pumping with out creating adverse effects on other water users. This includes the possible effects on other wells in the vicinity as well as any impact on the contribution of groundwater to surface water flows.

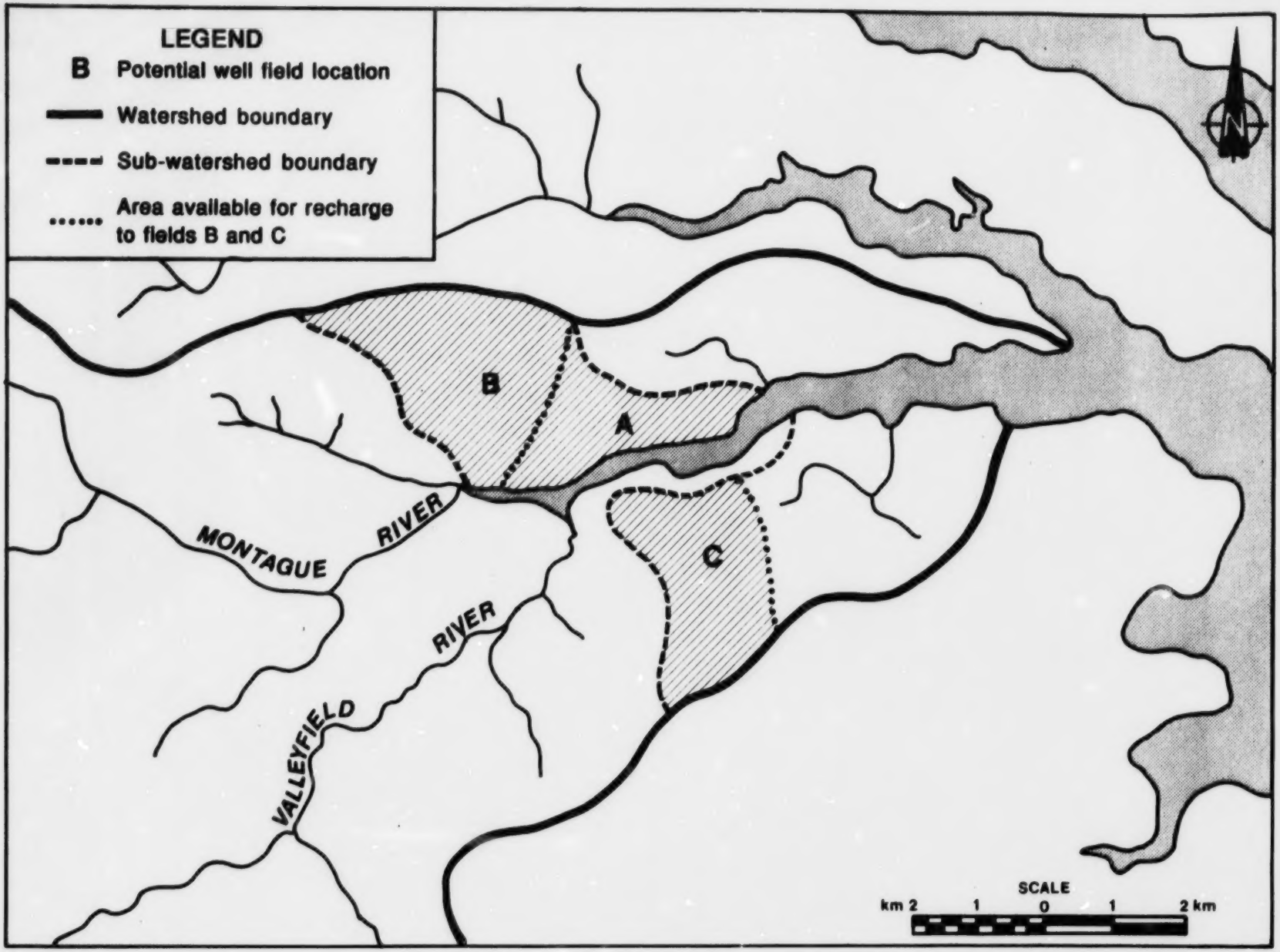

LEGEND
B Potential well field location
Watershed boundary
Sub-watershed boundary
Area available for recharge to fields B and C
B
A
C
MONTAGUE RIVER
VALLEYFIELD RIVER
N
SCALE
km 2 1 0 1 2 km

Figure 11

In Prince Edward Island surface water divides and groundwater divides are generally thought to coincide (Francis, 1989), allowing the delineation of hydrogeological regimes into systems based on surface watershed extent.

Figure 11 outlines the two watershed areas in which three potential well fields might be located; the Langley Packers site (A on figure 11), an area to the north west of the community (B on figure 11) and an area in the south eastern portion of the community (C on figure 11). The level of groundwater withdrawal possible without adverse impacts to other water users is a function of the areal extent of the watershed contributing water to the well field, and can be based on the amount of available recharge.

For the purposes of this report it can be assumed that up to 50% of the available recharge may be safely withdrawn without adversely affecting stream flows in the area. Typical recharge rates on the Island are in the range of 35 % of annual precipitation which averages 1100 mm . Using these assumptions the amount of water potentially available at each of the three sites shown on figure 11 has been calculated.

For site A near the former Langley Packers plant, all the watershed area above the site would be expected to contribute to groundwater flow making withdrawals in the order of 5000 m^3/ day possible assuming that the radius of influence from pumping did not cause undo interference with existing wells. Further up the same watershed at site B, only the portion of the watershed above the dotted line on figure 11 would be expected to be available to a well field. Under the same assumptions, groundwater withdrawals of 3500 m^3/day would be possible.

Site C is near the top of a different watershed and the amount of water available for exploitation would depend on how far down the watershed the supply wells were located. Based on the area above the dotted line in this watershed, withdrawals in the range of 2000 m^3/day would be possible. In the event that additional water supply was required from this site, it presumably could be secured by moving further down the watershed.

If a well field was located near the top of this watershed, it is possible that adjacent watersheds, such as the one immediately to the west, would also contribute water to the well field, assuming that the hydrogeological divide would migrate to the west as a result of reduced water table elevations in the vicinity of the well field.

Considering that the estimated current demand for water in the Town of Montague is in the range of 545 m^3/day, it is apparent that any of these three potential well field locations would be able to support the necessary groundwater extraction rates, leaving ample reserve capacity for future residential or industrial development. It should be noted of course that these figures relate to available water resources in the ground, and that the feasibility of developing the supply from a well field is another matter. As noted above however, the available pump test data suggests that this should not be difficult.

6.2 Groundwater protection strategies

The importance of groundwater resources to the health and welfare of the Island communities is well recognized. To a lesser extent, the importance of implementing sound, far sighted strategies aimed at protecting this valuable resource is also appreciated. The following discussion attempts to provide some focus to the issue, by presenting some possible approaches to the development of a comprehensive groundwater protection strategy.

The issue of groundwater protection can be separated into two components: specific recommendations for the protection of central water supply wells or well fields; and general considerations pertinent to the establishment and operation of on - site water supplies and protection and preservation of groundwater resources in general.

It is worth commenting at this point that even if a community has no intention of developing a central water supply in the foreseeable future (and indeed, such a consideration may not be appropriate to the development plans of a community), it is highly desirable to consider this possibility, and to be aware of the requirements and constraints involved in the development of a central water supply. This exercise ideally would involve the identification of suitable locations for the development of such a supply and appropriate strategies to preserve the resource for future use.

Well field protection

Unlike the processes that lead to the contamination of surface water bodies, the degradation of groundwater resources is not subject to direct observation, and consequently more difficult to predict, correct and avoid. Once contaminants have been introduced into a groundwater system, their migration and fate is governed by a complex series of reactions and processes which depend on a number of parameters which may be only poorly documented . Consequently the prediction of the consequences of the introduction of contaminants into a groundwater reservoir in the vicinity of wells supplying a water supply system requires a number of approximations and assumptions of varying validity.

A number of approaches have been developed to provide varying degrees of protection to the wells supplying central water supply systems. In general, the object of these strategies is to designate a given area around the well or well field for which activities which have the potential to impact on the integrity of the water supply are regulated or prohibited.

"The major parameters in developing groundwater protection strategies for municipal water wells are legal, socio-economic and hydrogeological" (Allan Gregory, 1988), In this report suggested protective strategies are based primarily on hydrogeological parameters. It is recognized that the modification of these strategies in light of socio-economic factors is an inevitable and desirable aspect of the development of appropriate strategies for individual communities.

There are a variety of techniques which have been employed to define the extent of various groundwater protection zones. Three types of zones are considered in this report are defined below.

1) Radius of Influence - The areal extent of the cone shaped depression of the water table or piezometric surface, resulting from the pumping of water from a well or well field. Within this area it is recommended that no residential , commercial or industrial development takes place, and that restrictions be placed on agricultural activities. The area would be suitable however for the development of some types of recreational activities.

2) 60 day Delay Time Zone - Given information on the direction and magnitude of the hydraulic gradient and the aquifer characteristics, it is possible to estimate the velocity of groundwater or a contaminant towards a well under pumping conditions. The 60 day delay time zone represents the area within which a potential contaminant could migrate to the well within a 60 day period.

It is recommended that within this area, on - site sewage disposal systems, (i.e. septic systems), and the storage or handling of hazardous chemicals (including petroleum products) be prohibited. In addition any development proposals should be subjected to an environmental impact assessment, at least in regard to their potential impact on the integrity of the water supply system.

3) Catchment Area - A zone outlining the area in which groundwater is expected to flow to the well or well field, both under pumping conditions and under the existing natural hydrogeological flow regime. Within this area major development proposals or proposed land use changes should be subjected to an environmental impact assessment.

Each of these approaches has its strengths and weaknesses, and it is perhaps advisable to develop well field protection measures which incorporate aspects of each approach.

Without a specific site and information on the aquifer characteristics at that site it is difficult to define definitively the extent of any of these zones. However by using typical values for these aquifer parameters from data in the Montague area, some indication of the size of these zones can be given. At the least this will provide an appreciation for the order of magnitude of these zones, and hopefully can also provide information for planning purposes. At such time as a well field is developed,

a more refined estimate, based on site specific information, can be developed.

It should be noted however, that even with site specific data, some of these parameters exhibit temporal variability (eg. recharge to the aquifer) while others may show spatial variability (eg. hydraulic conductivity of the aquifer), thus certain simplifying assumptions usually must be made in any event.

As a basis for the determination of the extent of these zones, certain simplifying assumptions must be made such as the pumping rate from individual wells, the local topography, and the aquifer characteristics in the vicinity of the well field. It will be assumed here that the average daily water requirements (extracted from a single well) will be in the range of 545 m^3/day (approximately 6.4 L/sec.) and that pumping will be continuous with no recharge to the aquifer for a period of 180 days.

The transmissibility of the aquifer will be assumed to be 208 m^2/day and the storage coefficient will be taken as 3×10^{-4}. Effective porosity of the aquifer will be assumed to be 1%. Finally it will be assumed that the well field is developed in an area where the slope of the water table (ie. hydraulic gradient) will be 1%.

With this information, the areal extent of a series of hypothetical well head protection zones can be estimated. In practice of course, more than well is likely to be required (particularly to meet peak demand, as well as providing a backup supply to the system in the event of mechanical failure or contamination of one of the supply wells.

Radius of influence:

When water is being pumped from a well, the water table is depressed in the surrounding area, creating a change in the hydraulic gradient towards the well. This cone shaped depression is commonly referred to as the "cone of depression" or the "radius of influence" of the well.

Various techniques can be employed to estimate the extent of this area, which will depend on the duration and rate of pumping, aquifer characteristics, and other hydrogeological parameters. Because from a theoretical standpoint, the areal extent of the cone of depression may in fact be infinite, some practical boundary must be assumed. For the purposes of this study, the radius of influence will be defined as the point at which the hydraulic gradient induced by pumping is less than or equal to the natural hydraulic gradient (ie, at a distance at which it is difficult to distinguish the effects of pumping on the natural flow system.

For a well pumping under the circumstances outlined above the radius of influence would be expected to be a slightly elliptical area, extending approximately 100 m in an upslope direction and 75 m in a downslope direction and perpendicular to the slope.

As noted above, there are other ways of determining the radius of influence of a well. In a report completed in 1965 (Laurie Coles & Ass., 1965) it was predicted that the virtual radius of influence for the high capacity wells at the Langley Packers Site ranged from 440 m to 535 m. While a significant portion of the differences between these two estimates can be explained by differences in pumping rates and assumptions regarding some aquifer characteristics, much of the discrepancy lies in the manner in which the effective radius of the well is determined. Neither method is strictly speaking correct or incorrect.

Delay Time Zone:

The rate at which contaminants can travel towards a well is a function of a number of factors, including the nature of the aquifer materials, the natural hydraulic gradient, and the hydraulic gradient induced by pumping. As might be expected the higher the pumping rate, the more rapidly a contaminant can be expected to migrate towards the well. A 60 day delay time zone should provide protection from most pathogenic organisms (60 days is the maximum time most pathogens are believed to survive in groundwater), and could also provide a sufficient buffer zone that an alternative well location could be sought if a particularly serious incident of contamination threatened the water supply.

Thus for instance, if a spill of a hazardous material occurs at the boundary of this zone, the community would have approximately 60 days before the contaminant was expected to reach the well, in which to take whatever remedial or corrective action was possible.

Based on the assumptions outlined above, such a zone would have an upslope extent of approximately 650 m and a down slope extent of 150 m. While the upslope extent of this zone may seem surprisingly large, it should be noted that under the same circumstances, groundwater would travel approximately 640 m in the same 60 days under the natural hydraulic gradient alone. Perpendicular to the slope, the extent of this zone would be approximately 225 m in each direction from the well.

Catchment Area:

Without site specific information it is not impossible to define the extent of this zone. The down slope extent of the zone would be expected to be the same as for the delay time zone in most cases, and the upslope direction will generally be the point at which some significant topographic divide. In actual practice the extent of this zone and the 60 day delay time zone are roughly comparable given the topography found in many Island communities.

7. Conclusions

The investigations conducted as a part of this study indicate that the Town of Montague is situated in an area of abundant groundwater resources, with few natural water quality constraints. At the same time, the effects of development pressures on this resource are becoming apparent, and there area a number of instances where water quality appears to have been adversely effected by man made activities. It is probable that groundwater quality will be the greatest constraint in the development and maintenance of water supplies in the Montague area in the future.

Although generally of only localized extent, groundwater quality has been affected by spills of petroleum products, nitrates from agricultural activities, isolated incidences of bacterial contamination, and chlorides form the storage of road salt. In addition, while more difficult to identify and document, the relatively high density of development in the area may be leading to more subtle degradation of natural water quality, which may provide pathways for less desirable surface and near surface waters to access deeper portions of the aquifer.

Other activities accompanying denser development which can gradually lead to gradual degradation of water quality include road salting and an increased number of potential commercial and industrial activities that have the potential to impact on the quality of groundwater resources.

The community is fortunate in having a number of areas which have good potential for water supply development close at hand. Pump test data reviewed as a part of this study show a sufficient resource to meet the communities present and probable future needs just east of the town, at the site of the former Langley Packers plant. In addition a number of other areas show good potential based on the available data.

There are a number of steps which the community could take to help minimize the degradation of groundwater quality. Because most of the Town of Montague is already developed, much of future development is likely to occur in adjacent communities and this development may have an impact on water quality not only in the area to be developed but also in the Town of Montague itself. Cooperation between municipalities on issues relating to environmental servicing (eg. hooking up of new subdivisions to existing central sewer service or ensuring adequate lot sizes for satisfactory performance of on-site services etc.) will help to preserve the quality of groundwater.

Building permits for undertakings which will involve commercial or industrial development or any other environmental sensitive activity could be referred to the Department of the Environment for review. Increased public awareness about water quality issues, particularly in areas

such as the importance of properly abandoning contaminated or unused wells, the safe storage and handling of hazardous materials including hydrocarbons will lead ultimately to better management of the resource.

On a more technical level, a general water quality survey would provide greater insight into the status of groundwater quality in the community. Because a very significant number of the water quality analyses on file with the Department of the Environment are in response to problems, the data base may be seriously biased towards problem areas. A more objective assessment of water quality in the area could help provide a sound basis for planning and decision making on issues relating to the development or preservation of the Town's groundwater resources

If in the future, the community decides to move to centralized water supply or not, it would be prudent to identify land for the future development of alternate sources of supply, and to implement measures which would help ensure the continued integrity of this resource against the day in which it is needed.

References:

Francis, R.M., 1989: Hydrogeology of the Winter River Basin, Prince Edward Island Department of the Environment

Gregory, A., 1988: Inventory and review of New Brunswick municipal groundwater supply areas, prepared for Environment Canada, Consevation and Protection, Atlantic Region

Health and Welfare Canada, 1989: Guidelines for Canadian Drinking Water Quality, Dept. of Supply and Services, Ottawa

MacDougall and Veer, 1981: Soils of Prince Edward Island, Agriculture Canada, Charlottetown, Prince Edward Island

Prest, V.K.,1973: Surficial Deposits of Prince Edward Island; Geol. Surv. Can., Dept. of Energy Mines and Resources, Map 1366 A

Robinson, J.W., 1986: Guidelines for aquifer pumping tests, Water Resources Division, Newfoundland Department of the Environment

Van de Poll, H.W., 1981 Geology of Prince Edward Island; Prince Edward Island Department of Tourism, Industry and Energy

APPENDIX I

WATER WELL DATA

APPENDIX I
MONTAGUE

WATER WELL DATA

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Knox, James	751201	524100	5111400	60	100	24	21	8	1	0-18 Till 18-60 Sandstone	
MacDonald, Leonard	850529	524100	5118100	50	150	25	31	8	15	0-28 Till 28-50 Sandstone	31 50
Horne, Barry	760108	524300	5109400	100	85	60	35	5	30	0-5 Sand till 5-100 Hard-coarse claysand, sandstone	80 83 96 100
Murphy, Carole	740809	524502	5112092	50	75	32	35	8	1	0-30 Fractured sandstone 30-50 Sandstone	
King, Laird	790911	524800	5109300	70	75	70	42	4	8	0-35 Till 35-70 Sand, sandstone	70 73
MacIntire, Garnet	730813	525100	5112294	70	75	30	25	8	1	0-20 Fractured sandstone 20-70 Sandstone	
Nabuurs, Harry	731208	525100	5112700	50	75	30	22	10	1	0-16 Soft sandstone 16-50 Sandstone	
Peardon, Glen	751006	525200	5111500	100	50	60	28	7	1	0-25 Till 25-100 Sandstone	
Brown, Tony	790823	525400	5111800	75	50		22	7	5	0-20 Till 20-75 Sandstone	28 31 75 78
Sharrett	830720	525500	5111700	57	15	5	25	8	10	0-16 Till, fractured sandstone, clay 16-57 Fractured sandstone, sandstone	34 38 50 53
Koke, Jacob	801002	525500	5114800	70	125	25	29	10	5	0-28 Claysand 28-70 Sandstone, claysand	70 73
Johnstone, Dennis	800905	525600	5111800	75	75	31	25	5	10	0-37 Claysand, sandstone 37-75 Clay, sandstone	31 34 75 78
McKenna, Wayne	801020	525700	5111600	75	50	46	40	7	8	0-38 Till 38-75 Sandstone	46 49
Vozzo, Benny	790727	525700	5114900	52	150	16	18	10	5	0-18 Till, claysand, sandstone 18-52 Claysand, sandstone	18 19 52 55
Power, Bill	720705	525701	5112792	65	110	18	20	12		0-18 Fractured sandstone 18-65 Sandstone	
Tesselaar, Gary	830801	525800	5110295	55	100	35	22	8	1	0-18 Clay till 18-55 Fractured sandstone	
King, Laird	771116	526030	5112090	90	75	30	44	10	1	0-25 Till 25-90 SMRC sandstone	44 90

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (lgpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Bradley, Ernest	770620	526040	5112000	60	30	25	43	8	6	0-29 Till 29-75 SMRC sandstone	43 75
King, Laird	800704	526100	5110500	75	250	42	23	7	10	0-20 Till 20-75 Sandstone	42 45 75 78
Asthike, Bill	750715	526100	5111400	100	125	75	29	8	1	0-22 Till 22-100 Sandstone	
Fraser, Joey	751104	526100	5112100	90	50	50	35	7	1	0-30 Till 30-90 Sandstone	
Owen, David	751024	526100	5112400	70	80	32	60	7	1	0-57 Till 57-70 Sandstone	
MacDonald, Warren	751129	526100	5112600	80	100	48	42	8	1	0-36 Till 36-80 Sandstone	
Johnston, Leon	751117	526100	5112600	85	100	45	36	7	1	0-32 Till 32-85 Sandstone	
White, John	751111	526100	5112600	85	100	54	30	7	1	0-26 Till 26-85 Sandstone	
Ferguson, Bob	751016	526100	5112900	105	100	60	33	6	1	0-28 Till 28-105 Sandstone	
Thompson, Billy	730921	526101	5110094	60	100	30	20	9	1	0-15 Fractured sandstone 15-60 Sandstone	
MacDonald, Milton	741104	526103	5112492	80	90	45	28	7	1	0-25 Till 25-80 Sandstone	
Greene, Allan	800725	526200	5110600	85	225	50	34	7	10	0-32 Till 32-85 Sandstone	80 83 85 88
Carruthers, Bruce	771130	526200	5111600	70	75	30	36	6	7	0-14 Sandstone 14-70 Claysand, sandstone	63 68
McClare, E.	721029	526200	5112400	75	75	42	35	8	1	0-29 Till 29-75 Sandstone	
Prebuilt Structures	810703	526200	5115000	120	130	79	39	10	10	0-14 Sand, till, sandstone 14-120 Shale, sandstone, claysand	85 90 110 115
Medical Center	801208	526250	5112600	105	100	50	44	8	9	0-24 Till, claysand, sandstone 24-105 Sandstone, claysand	58 81 96 99
Murphy, Eugene	720821	526298	5112293	72	75	31	21	8	8	0-19 Clay till 19-72 Sandstone	60 63 70 73

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
MacLure, Evelyn	870519	526300	5112700	100	100	28	40	10	10	0-10 Till 10-100 Sandstone and claystone	40 100
New Hospital	700920	526300	5112750	204	75	30	46	20	20	0-38 Clay, FRDR sandstone, claystone 38-204 Sandstone, claysand	60 70 110 115 190
Belcourt Const. Ltd.	780607	526300	5112793	85	125	25	29	8	1	0-22 Till 22-85 Sandstone	
Clements, Kenneth	720525	526300	5113693	70	90	18	20	19		0-17 Brick clay 17-70 SMRC	
Knox, James	711208	526301	5112593	90	80	46	32	8	10	0-29 Fractured clay, sandstone 29-90 Clay, sandstone	75 78 85 88
Belcourt Const. ltd.	780604	526301	5112693	85	125	25	22	7	1	0-20 Till 20-85 Sandstone	
McGuire, James	711006	526399	5112394	77	85	32	33	8	10	0-77 Fractured sand, clay, sandstone	65 68 75 78
Morris, Barry	740510	526400	5111092	40	75	20	29	9	1	0-24 Light sandstone 24-40 Sandstone	
Llewellyn, Wayne	750731	526400	5111300	95	100	70	29	7	1	0-25 Till 25-95 Sandstone	
Jackson, Thomas	750628	526400	5112093	85	50	30	32	9	1	0-27 Till 27-85 Sandstone	
Ramsay, Elmer	841221	526400	5112500	70	75	27	32	10	5	0-12 Till 12-70 Sandstone, claysand	
Hospital	860821	526400	5112660	265	100	35	209			0-205 - 205-265 Sandstone, some claystone	220 223 240 243
King, Laird	790905	526400	5112700	90	75	30	44	5	10	0-42 Till 42-90 Sandstone	
Prebuilt Structures	860827	526400	5112700	80	100	29	47	8	10	0-15 Till, sand 15-80 Sandstone, some claystone	70 75
Campbell, Martin	751216	526400	5112800	90	100	30	25	7	1	0-21 Till 21-90 Sandstone	
Campbell, Martin	751216	526400	5112900	90	100	46	23	7	1	0-20 Till 20-90 Sandstone	
Douglas, Lyman	770728	526400	5112900	95	100	20	95	6	4	0-39 Till 39-95 Sandstone	

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
McPhee, Wayne	750606	526401	5112792	75	75	25	35	8	1	0-31 Till 31-75 Sandstone	
Belcourt Const. Ltd.	760608	526401	5112792	85	125	25	28	7	1	0-25 Till 25-85 Sandstone	
Bradby, Fred	750825	526401	5112891	90	85	50	40	7	1	0-36 Till 36-90 Sandstone	
Laybolt, Francis	750827	526401	5112891	80	85	50	40	8	1	0-36 Till 36-80 Sandstone	
Belcourt Const. Ltd.	760609	526401	5112891	95	125	50	18	8	1	0-18 Till 16-95 Sandstone	
Harper, Steve	730523	526402	5112592	85	85	20	25	50	5	0-20 Clay, till 20-85 Fractured sandstone	
Somers, Henry	740902	526402	5112592	70	90	30	23	8	1	0-19 Till 19-70 Sandstone	
Buchanon, Freeman	730606	526402	5112692	75	75	26	21	10	4	0-15 Light sandstone 15-75 Sandstone	
Clarey, John	730524	526402	5112692	65	75	20	26	10	4	0-20 Fractured sandstone 20-65 Sandstone	
Campbell, Marty	740808	526402	5112692	70	100	34	29	8	1	0-10 Till 10-70 Sand, sandstone	
Belcourt Const. Ltd.	760604	526402	5112692	85	125	27	32	7	1	0-28 Till 28-85 Sandstone	
Campbell, Dan	711007	526499	5112593	75	85	30	29	8	10	0-25 Fractured sand, sandstone 25-75 Sandstone	65 70
Hubley, Alan	790427	526500	5112000	65	75	30	42	10	5	0-24 Till 24-65 Sandstone, claysand	65 68
Fraser, Alfred	730726	526500	5112492	75	75	22	24	9	1	0-5 Clay till 5-75 Fractured sandstone	
MacLeod, Vernon	750722	526500	5112500	75	75	30	27	8	1	0-27 Till 25-75 Sandstone	
Montague Consolidated	710604	526500	5112500	175	75	27	54			0-44 Clay, sand, sandstone 44-175 Sandstone, clay	55 60 115 125 160 170
Montague High	710503	526500	5112500	175	75	24	51			0-15 Clay, sand 15-175 Sandstone, clay	75 80 110 115 160 170

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
King, Laird	760906	526500	5113500	80	100	40	38	7	1	0-35 TIll 35-80 Sandstone	40 43
Collins, Wallace	740809	526599	5111882	79	25	33	68	8	10	0-63 Sand, till 63-65 Hard sandstone, MDGD	70 75
Campbell, Barry	710719	526600	5112300	72	50	28	21	7	15	0-17 Fractured sandstone 17-72 Sandstone, claystone	50 53 68 71
Griffin, Ray	701117	526600	5112300	45	50	16		15			
Campbell, Martin	760720	526600	5112400	75	75	22	46	8	1	0-30 TIll 30-75 Claysand, sandstone	
Prebuilt Structures	840604	526600	5112400	67	35	36	42	8	10	0-9 TIll 9-67 Sand, clay, sandstone	48 52 60 62
King, Laird	770815	526600	5112500	85	75	40	35	8	7	0-32 TIll 32-85 Sandstone	40 85
PEI Housing Corp.	841220	526600	5112500	105	75	3				0-55 TIll, claysand 55-105 Claysand, sandstone	40 45
MacDonald, Stewart	870622	526600	5112600	104	100	50	40	10	10	0-35 Sand 35-104 Sandstone and clay	50 55 90 100
Kennedy, Howard	750523	526600	5112693	80	80	18	22	7	1	0-19 TIll 19-80 Sandstone	
MacDonald, E.A.	750814	526602	5111294	105	85	72	25	6	1	0-23 TIll 23-105 Sandstone	
Sorrey, David	721011	526700	5111100	25	25	6	20	14	1	0-18 Clay till 18-25 Sandstone	
Montague High	810903	526700	5112400	160	50	30	66	20	1	0-5 Clay 5-160 Sandstone, claysand	80 83 120 123 150 153
Mormon Church	870421	526700	5113000	102	100	25	40	12	10	0-7 TIll 7-102 Sandstone, some claystone	40 102
Wheeler, Munroe	800904	526700	5114900	65	125	50	15	5	10	0-12 Claysand 12-65 Sandstone	65 68
Wheeler, Munroe	800911	526700	5114900	70	125	25	29	10	5	0-18 Claysand 18-70 Sandstone, claysand	70 73
Fraser, Randy	851008	526700	5115400	80	75	40	23	6	10	0-20 TIll 20-80 Sandstone	40 44

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Fraser, Charles	721101	526701	5112493	80	100	34	67	9		0-65 Fractured claysand, sandstone 65-80 Sandstone	
Montague Fire Hall	721016	526701	5112694	110	85	60	23	10		0-20 Clay till, FRCD sandstone 20-110 Sandstone	
Cranford, Gerald	710617	526710	5112180	55	50	17	16	15	10	0-14 Soft clay 14-55 Hard sandstone	50 53
McGowan, Murdoch	741027	526798	5112694	90	85	60	39	6	1	0-35 Till 35-90 Sandstone	
Sorrey, David	721011	526802	5111893				20	14		0-5 Clay, brick clay 5-25 Light sandstone, sandstone	
Nicholson, Lloyd	710514	526900	5112250	90	25	30	68	18			
King, Laird	801026	526900	5112300	85	75	30	55	6	9	0-54 Sand, silty claysand 54-85 Sandstone	55 58 85 88
Pepler, Victor	751121	526900	5112500	75	50	40	69	7	1	0-67 Till 67-75 Sandstone	
Nicholson, Norman	751213	526900	5112600	50	50	25	27	8	1	0-25 Till 25-50 Sandstone	
LLewellyn Store	770516	526900	5112600	93	80	36	36	6	15	0-18 Sand, till 18-93 Sandstone, claysand	52 56 80 85
Power, Marguerite	751202	526900	5112700	85	75	50	36	7	1	0-32 Till 32-85 Sandstone	
MacLeod, Vernon	710630	526900	5113750	40		13	23	15			
Riley, Alnoxso	760910	526900	5113900	85	100	30	44	8	1	0-20 Till 20-85 Claysand, sandstone	44 80 80 85
Metcalfe, Terry	770603	526900	5114000	73	90	20	31	8	10	0-12 Sand, till 12-73 Fractured sandstone, sandstone	65 65
Moarse, Wayne	770727	526900	5114200	65	100	12	35	7	8	0-30 Till 30-65 Sandstone	35 65
MacLean, Rob	860806	526900	5116500	65	75	31	22	10	10		31 65
MacGuigan, Dave	730630	526903	5113793	100	75	40	17	9	1	0-12 Light sandstone 12-100 Sandstone	

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Acorn, Fred	740625	526903	5113793	105	100	24	28	8	1	0-24 Fractured sandstone 24-105 Sandstone	
Beck, John	791126	527000	5112400	75	75	12	52	10	5	0-50 Silty claysand 50-75 Claysand, sandstone	55 58 68 71
Whitman's Supermarket	770715	527000	5113100	125	50	40	36	7	8	0-37 Till 37-125 Sandstone	40 43 123 125
Bank Nova Scotia	721116	527002	5112393	78	40	44	54	8	8	0-50 Sand till 50-78 Sandstone	
MacLean, Hayward	770725	527010	5112060	75	50	35	48	8	8	0-26 Till 26-70 Sandstone SMRC	48 70
Van Iderstine, Billy	800905	527030	5112040	65	25	30	43	10	5	0-40 Sand 40-65 Sandstone, claysand	43 65
Murphy, Ruby	770715	527040	5112010	55	25	30	33	8	8	0-24 Till 24-55 Sandstone, SMRC	33 55
Montague Lions Club	771129	527060	5112050	70	25	8	55	20	1	0-20 Till 20-70 Sandstone, claysand, SMRC	55 70
Smith, Ian	771005	527070	5111040	75	125	30	30	10	6	0-24 Till 24-75 SMRC sandstone claysand	30 75
Beck, Jock	710728	527080	5113020	60	50	28	10	7	15	0-5 Till 5-60 Sandstone	52 58
Murphy, Tom	750909	527098	5113593	95	75	45	34	7	1	0-95 Till, sandstone	
Fraser, David	750704	527100	5111600	60	100	20	22	8	1	0-17 Till 17-60 Sandstone	
Tri-County Real Estate	770808	527100	5112100	60	20	25	48	10	5	0-24 Till 24-60 SMRC	60 63
Montague Dairy	850715	527100	5112100	120		30	68	20	5	0-10 Till 10-120 Sandstone and claystone	68 120
Somers Shoe Store	731009	527100	5112193	75	75	25	62	9	1	0-75 Fractured sandstone, sandstone	
Moysert, Marcel	720717	527100	5112200	35		16	19	12		0-10 Till 10-35 Sandstone	
Bank of Commerce	810803	527100	5112300	97	30	20	50	10	15	0-12 Till 12-97 Claysand, sandstone	60 65 85 90

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Poole, Gladys	850227	527100	5112500	83	75	36	41	10	10	0-31 Sandy till 31-83 Clay, sandstone	50 60 70 80
Smith Ian Fida Const.	790628	527100	5112800	90	75	39	39	10	10	0-9 Sandy till 9-90 Sandstone, claysand, shale	40 45 75 85
Fraser, Charles	720710	527102	5112693	165	60	40	24	8		0-20 Clay till 20-165 Fractured sandstone, sandstone	
MacLean, James	750607	527102	5112693	55	75	20	23	8	1	0-20 Till 20-55 Sandstone	
Senior Citizens Court	781206	527150	5112750	160	75	35	64			0-32 Clay, till, soft till 32-160 Sandstone, claysand	70 73 93 96 118 121
Vuozzo, Carl	720801	527199	5112793	80	50	38	23	12		0-19 Fractured claysand 19-80 Sandstone	
Reid, Cameron	751210	527200	5111100	105	100	67	21	7	1	0-20 Till 20-105 Sandstone	
Stewart & Beck Ltd.	751209	527200	511700	135	100	105	21	6	1	0-18 Till 18-135 Sandstone	
Metro Building Supplies	721113	527200	5112394	75	20	25	58	10		0-55 Clay till, fractured claysand 55-75 Sandstone	
White, Barry	770413	527200	5112400	75	75	15	60	7	10	0-60 Clay till 60-75 Sandstone	65 75
MacGillivary, Elmer	740515	527200	5112492	55	40	36	25	8	1	0-15 Clay till 15-55 Light sandstone, sandstone	
Schurmans Unit 3A	751027	527200	5112500	97	30	30	27	8	15	0-10 Clay till, sand 10-97 Sandstone	35 60 80 83 90 93
Prebuilt Structures	830323	527200	5112600	90	75	31	43	10	10	0-9 Sandy till 9-90 Clay, sandstone, claysand	55 65 80 85
Prebuilt Structures	830325	527200	5112600	90	75	30	43	10	10	0-9 Sandy till 9-90 Clay, sandstone, claysand	55 65 80 85
Handicap Center	790210	527200	5112800	85	75	32	32	5	10	0-20 Silty soft claysand, claysand 20-85 Sandstone, sand, claysand	32 35 80 83
Fraser, F. W.	710522	527200	5112800	55	50	20	23	15			
Prebuilt Structures	830128	527200	5112800	90	75	30	38	10	10	0-9 Sandy till 9-90 Claysand, fractured sandstone stone, clay ay	55 60 75 85

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Prebuilt Structures	830128	527200	5112850	90	75	30	37	10	10	0-9 Sandy till 9-90 Claysand, fractured sandstone, clay	55 60 75 85
Smith, Ian	770804	527200	5112900	95	25	52	37	8	1	0-29 Till 29-95 Soft sandstone, sandstone	52 59
Smith, Ian	770805	527200	5112900	95	25	51	46	8	1	0-40 Till 40-95 Sandstone	51 95
Smith, Ian	770809	527200	5112900	95	25	65	45	8	1	0-35 Till 35-95 Soft sandstone, sandstone	65 95
Smith, Ian	770808	527200	5112900	90	25	54	48	8	1	0-43 Till 43-90 Sandstone	54 90
Smith, Ian	770805	527200	5112900	95	25	52	42	8	1	0-38 Till 38-95 Sandstone	52 95
Smith, Ian	770804	527200	5112900	90	25	50	48	8	1	0-40 Till 40-90 Sandstone	50 90
Graham, Charlie	720713	527200	5113000	55		24	16	10		0-12 Till 12-55 Sandstone	
Young, Ralph	730515	527201	5113091	65	75	25	20	9	3	0-15 Clay till 15-65 Sandstone	
Young, Ralph	721206	527202	5112794	100	50	35	39	15	10	0-29 Soft clay till, shale 29-100 Brick clay, hard SMRC	65 68
Young, Ralph	721207	527202	5113643	100	95	42	36	15	10	0-33 Soft claysand 33-100 Hard SMRC, hard claysand	58 61
Schurmans Unit 2A	751115	527220	5112640	95	50	37	30	10	1	0-29 Till 29-95 Red sandstone	51 54 70 73 85 88
Schurmans Unit 2B	751115	527220	5112650	94	50	37	33	10	1	0-30 Till 30-94 Red sandstone	52 55 71 74 85 88
Schurmans Unit 1A	751115	527220	5112670	94	50	37	30	10	1	0-28 Till 28-94 Red sandstone	51 54 74 77 85 88
Schurmans Unit 1B	751115	527220	5112680	95	50	37	30	10	1	0-28 Till 28-95 Red sandstone	50 53 74 77 84 87
Wood, Jim	860822	527250	5111650	115	100	65	44	8	7	0-15 Till, silt, some sandstone 15-115 Sandstone, some claystone	75 78 105 108
McKenna, George	791204	527250	5112000	95	50	55	54	8	7	0-5 Till 5-95 Claysand, gravel, sandstone	78 81

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
Schurmans Unit 5B	751024	527250	5112500	95	40	35	32	8	15	0-12 Clay till 12-95 Sand, sandstone	80	85	80	83	90	93
Schurmans Unit 5A	751030	527250	5112500	95	30	35	37	8	15	0-12 Clay till 12-95 Sand, sandstone	85	90	80	83	90	93
Schurmans Unit 4B	751101	527300	5112500	95	30	36	29	8	15	0-12 Clay till 12-95 Sand, sandstone	80	85	80	83	90	93
Schurmans Unit 5A	751023	527300	5112500	93	30	36	35	8	15	0-12 Clay till 12-93 Sand, sandstone	85	90	80	83	90	93
Harris, Brent	711125	527300	5112500	115	100	70	15	15		0-12 Clay till 12-115 Sandstone						
Schurmans Unit 3B	751028	527300	5112550	96	30	35	30	8	15	0-13 Clay till 13-96 Sand, sandstone	80	85	80	83	90	93
Schurmans Units 6B	751029	527300	5112550	96	30	35	33	8	15	0-12 Clay till 12-96 Sand, sandstone	85	90	80	83	90	93
Schurmans Unit 4A	751115	527300	5112660	94	50	36	30	10	1	0-28 Till 28-94 Red sandstone	53	58	72	75	85	88
Campbell, Martin	760214	527300	5112700	85	75	30	48	10	5	0-21 Sandy claysand, till 21-85 Sandstone, claysand	82	85				
Campbell, Martin	760214	527300	5112700	90	75	30	37	10	5	0-15 Till 15-90 Sandstone, claysand	70	73				
Dockendorff, Harold	760825	527300	5113400	85	85	35	42	8	1	0-10 Till 10-85 Claysand, sandstone	42	70	70	86		
Collings, Stanley	720920	527301	5111693	125	120	70	25	8		0-22 Fractured clay, sandstone 22-125 Sandstone						
McCarron, Steve	720731	527302	5113192	70	125	40	25	8		0-10 Fractured sandstone 10-70 Sandstone						
Dockendorff, John	720620	527302	5113192	55	80	20	20	11		0-16 Fractured clay, sandstone 16-55 Sandstone						
Blue, Albert	721009	527302	5113393	85	85	40	20	12		0-18 Fractured sandstone 18-85 Sandstone						
Bank of Commerce	760611	527303	5112094	75	75	42	36	7	1	0-28 Till 28-75 Sandstone						
Southern Kings Reg. Ser.	750101	527350	5111600	195	125	58	53	40	10							

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Bevan Bros. Plumbing	750326	527389	5111444	195	120	58	53	30	30	0-22 Clay, shale 22-195 Brick clay, SMRC	137 140
Ocaner, Elmer	751107	527400	5111900	115	100	70	10	8	1	0-6 Till 6-115 Sandstone	
Prebuilt Structures	830131	527400	5111900	105	100	45	43	10	10	0-11 Sandy till 11-105 Fractured sandstone, sandstone, clay	80 70 90 100
Prebuilt Structures	830131	527400	5111860	105	100	45	43	10	10	0-11 Sandy till 11-105 Sandstone, fractured sandstone, clay	80 70 90 100
Jamieson, Violett	751106	527400	5112100	40	25	17	32	8	1	0-27 Till 27-40 Sandstone	
Bank of Commerce	780811	527400	5112100	75	80		36	7	1	0-20 Till 20-75 Claysand, sandstone	42 75
Schurmans Unit 8A	751115	527400	5112840	94	50	36	33	10	1	0-31 Till 31-94 Red sandstone	48 51 68 71 84 87
Schurmans Unit 8B	751115	527400	5112860	92	50	35	34	10	1	0-32 Till 32-92 Red sandstone	48 51 69 72 85 88
Schurmans Unit 7A	751115	527400	5112880	93	50	34	34	10	1	0-30 Till 30-93 Red sandstone	52 55 73 76 88 91
Schurmans Unit 7B	751115	527400	5112870	95	50	34	35	10	1	0-32 Till 32-95 Red sandstone	52 55 73 76 78 88
Campbell, Art	850705	527400	5113200	70	75	28	21	7	15	0-18 Till 18-70 Sandstone	28 70
Fitzgerald and Snow	721028	527401	5111893	100	100	85	20	9		0-16 Fractured sandstone 16-100 Sandstone	
Shaw, Cyrus	720704	527403	5113393	70	85	35	27	9		0-25 Fractured claysand, sandstone 25-70 Sandstone	
Dept. of Comm. Affairs	850629	527450	5113290	400	80	37	41	150	1440	0-23 Clay till, soft FRCD sandstone 23-400 Claysand, sandstone	42 45 62 65 75 78
Johnston, Kennie	720925	527498	5111793	85	110	65	20	10		0-17 Fractured sandstone 17-85 Sandstone	
Clements, Kenneth	711027	527499	5111592	110	100	54	14	14	99	0-10 Clay sandstone 10-110 SMRC	
Campbell, Martin	711106	527499	5111592	70	100	42	18	15	99	0-15 Fractured clay, sandstone 15-70 SMRC	

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Campbell, Martin	711108	527499	5111592	115	100	54	22	14	99	0-17 Fractured clay, sandstone 17-115 SMRC	
Campbell, Martin	711117	527499	5111592	115	100	54	20	14	99	0-15 Fractured clay, sandstone 15-115 SMRC	
Clements, Kenneth	711026	527499	5111592	114	140	49	21	10	10	0-18 Fractured clay, sandstone 18-114 Sandstone	100 110
Ellsworth, Dave	770630	527500	5111400	113	125	58	35	7	10	0-32 Till 32-113 SMRC, sandstone	58 113
Wood, Lorna	740607	527500	5111493	47	100	32	27	8	10	0-20 Claysand, till 20-47 Hard sandstone, soft sandstone	40 43
Watson, Kathrine	841218	527500	5111900	128	100	75	36	8	5	0-32 Till 32-128 Claysand, sandstone	75 78
Jenkins, Weston	860501	527500	5112100	66	50	31	22	7	10	0-19 Till 19-66 Sandstone	31 66
Lanes Tourist Court	820430	527500	5112400	70	25	36	44	10	4	0-40 Mud 40-70 Sandstone, claysand	44 70
Dept. of Comm. Affairs	821006	527500	5112550	52	30	31	22	3	5	0-10 Silty fine sand, sandstone 10-52 FGRD sandstone, siltstone, claysand	30 40 49 50
Dept. of Comm. Affairs	650630	527500	5113290	400	80	40	38	150	1440		
Bonnell, Dr. Lorne	750811	527501	5112093	80	75	55	38	7	1	0-35 Till 35-80 Sandstone	
Jamieson, Ron	730819	527502	5111894	110	100	50	29	10	1	0-20 Clay till, FRCD sandstone 20-110 Sandstone	
Dept. of Comm. Affairs	821006	527510	5113430	45	80	18	17	1	5	0-10 Sand, fractured sandstone 10-45 Clay, hard fractured sandstone	38 40
Dept. of Comm. Affairs	821006	527520	5113580	35	75	5	18	6	5	0-11 Claysand, till, silty fine sand 11-35 Hard fractured sandstone	18 20 32 33
Prebuilt Structures	790618	527600	5111590	130	130	43	44	10	8	0-41 Clay till 41-130 Sandstone	123 128
MacNally, Lea	800606	527600	5111600	115	100	50	42	8	7	0-4 Till 4-115 Soft sandstone, claysand, sandstone	78 79 104 107
Johnston, Sadie	730511	527600	5111694	110	100	45	22	10	5	0-18 Fractured sandstone 18-110 Sandstone	

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Glover, Alden	751230	527800	5111800	120	109	70	31	7	1	0-28 Till 28-120 Sandstone	
Boehner, Lyle	731203	527800	5112584	100	100	75	35	7	1	0-30 Fractured clay 30-100 Sandstone	
King, Eldon	800917	527800	5113400	80	25	50	27	10	5	0-12 Till 12-82 Claysand, sandstone	50 80
MacIntyre Sheet Metal	841208	527800	5114500	110	75	27	42	16	10	0-21 Fractured sandstone, clay 21-110 Sandstone and claystone	45 50 70 75 90 105
Dept. of Comm. Affairs	821006	527850	5113600	35	80	14	17	10	5	0-12 Brown grey clay, fine sand 12-35 FGRD SLTY VFRD VRGD sandstone	32 33
Prebuilt Structures	801209	527700	5109300	73	100	24	35	15	10	0-15 Clay till, claysand 15-73 Claysand, shale, sandstone	40 45 60 70
Tupper, Pauline	870323	527700	5111800	140	100	60	110	10	10		110 140
MacLure, Preston	710927	527700	5112100	55	75	29	40	15		0-38 Till 38-55 Fractured sandstone	
Dept. of Comm. Affairs	821008	527700	5113800	30	75	5	16	2	5	0-22 Fine sand, clay, siltstone 22-30 Hard FGRD sandstone, siltsand, claysand	18 20 20 30
MacSwain, Lynn	720818	527702	5111593	115	125	64	25	9		0-22 Clay till fractured 22-115 Sandstone	
Scott, Merrill	720523	527703	5111394	60	115	23	21	18		0-18 Clay till, fractured sandstone 18-60 SMRC	
Campbell, Raymond	720802	527703	5111394	60	110	30	20	11		0-17 Fractured sandstone 17-60 Sandstone	
Prebuilt Structures	790612	527790	5111500	105	120	27	47	10	8	0-45 Clay till 45-105 Sandstone	96 99
MacLean, David	730612	527799	5111486	55	100	21	16	10	3	0-12 Light sandstone 12-55 Sandstone	
Rourke, David	730727	527799	5111594	60	75	26	20	8	1	0-15 Fractured sandstone 15-60 Sandstone	
King, Laird	700812	527800	5111700	70	75	42		15			
Young, Ralph	700831	527800	5111700	35	75	18		15			

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)					
Smith, Ina	770522	527800	5112100	115	100	60	38	7	6	0-30 Till, clay till 30-115 Soft sandstone, sandstone	80	95	105	115		
Dept. of Comm. Affairs	660822	527800	5113250	425	60	49	41	150	1440	0-18 Fractured sandstone, clay 18-425 Layered claysand, sandstone,	48	70	132	136	225	228
Annear, Ralph	721020	527802	5111795	110	110	70	18	8		0-18 Clay till, fractured sandstone 18-110 Sandstone						
Campbell, John	720631	527802	5111795	55	110	18		18		0-17 Fractured clay, sandstone 17-55 SMRC						
Hynes, Leonard	860529	527820	5111450	80	100	25	44	10	5	0-10 Till and silt 10-80 Sandstone	55	58	74	77		
Hynes, Leonard	860529	527830	5111450	80	100	25	42	10	5	0-15 Till and silt 15-80 Sandstone	55	58	75	78		
Hynes, Leonard	860529	527840	5111450	80	100	25	42	10	5	0-14 Till and silt 14-80 Sandstone	55	58	75	78		
Hynes, Leonard	860529	527850	5111450	80	100	25	40	10	5	0-15 Till and silt 15-80 Sandstone	55	58	75	78		
Hynes, Leonard	860529	527850	5111600	80	100	25	42	10	5	0-22 Till and silt 22-80 Sandstone	52	55	74	77		
Hynes, Leonard	860530	527850	5111600	80	100	25	42	10	5	0-20 Till and silt 20-80 Sandstone	54	57	74	77		
Campbell, Martin	701104	527860	5111710	70	50	30										
MacBeth, Sinclair	700722	527880	5111720	115	50	60		15								
MacLean, James	721005	527899	5111793	105	110	48	17	9		0-15 Fractured sandstone 15-105 Sandstone						
MacLean, Lorena	820812	527900	5109500	60	130	15	32	8	7	0-6 Open hole 6-60 Sandy clay, gravel, claysand, sandstone	45	48	52	55		
Mokler, Michael	821016	527900	5112000	154	100	90	43	12	1	0-70 Till, claysand 70-154 Layered claysand, sandstone	90	93	150	153		
Dept. Of Fisheries	810717	527900	5112300	77	50		64	10	5	0-54 Sand, claysand 54-77 Claysand, sandstone	64	75				
MacIntyre, Robert	850626	528900	5111500	55	75	25	23	7	10	0-21 Till 21-55 Sandstone	25	55				

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
MacNeill, Justin	741024	527901	5111493	105	100	75	42	7	1	0-36 Till 36-105 Sandstone	
Cummings, Gary	731016	528000	5111893	86	100	40	37	15	10	0-34 Clay 34-86 Sandstone	80 83
Senior Citizens Home	810410	528000	5111900	185	100	76	44	17	1	0-10 Sandy till 10-185 Shale, claysand, sandstone	70 80 115 120 150 160
Smith, Ian	780819	528000	5112300	100	25	60	46	5	15	0-62 Sandstone till 62-100 Claysand, sandstone	60 63 100 103
Smith, Ian	771004	528100	5112100	86	75	50	31	6	4	0-30 Till 30-86 Sandstone	50 85
Nicholson, Wilfred	740619	528101	5111091	110	75	50	24	7	1	0-20 Light sandstone 20-110 Sandstone	
Campbell, Martin	730524	528102	5111692	50	100	20	29	10	3	0-10 Clay till 10-50 Fractured sandstone, sandstone	
Mabon, David	730511	528102	5111793	75	75	35	18	9	3	0-12 Fractured sandstone 12-75 Sandstone	
Herring, Douglas	711006	528200	5112700	105	100	58	25	14		0-20 Till 20-105 Fractured sandstone, sandstone	
Young, Ralph	731119	528202	5110992	110	100	50	17	9	1	0-110 Sandstone	
Stewart, John	750209	528249	5111844	105	85	30	44	15	10	0-105 SMRC, brick clay, shale	75 78
King, Laird	770825	528300	5112100	110	50	48	39	6	5	0-35 Till 35-110 Sandstone	48 110
Clements, Kenneth	711029	528400	5112600	110	100	45	14	15		0-110 Clay sandstone, sandstone	
Sefarin, George	731126	528402	5113392	45	75	15	23	9	1	0-17 Fractured sandstone 17-45 Sandstone	
Robbins, Hugh	790531	528500	5112200	107	80	47	45	6	10	0-7 Till 7-107 Fractured soft sandstone claysand, sandstone	48 50 95 100
Dewar, Paul	730411	528503	5111894	110	75	25	23	20	4	0-18 Clay till, fractured sandstone 18-110 Sandstone	
Clarke, Ider	750801	528553	5111894	105	75	50	28	8	15	0-7 Clay till 7-105 Claysand, sandstone	55 60 95 100

Name	Date	East. (m)	North. (m)	Depth (ft)	G.S. Elev. (ft)	S.W.L. (ft)	Casing Length (ft)	Yield (igpm)	Time (min)	Geology	Aquifers (Water Occurrences)
Zahn, Art	800512	528600	5112600	44	25	21	30	10	10	0-11 Sandy till 11-44 Sandstone, shale	35 40
King, Harold	770919	528700	5111700	55	100	24	21	7	3	0-20 Till 20-55 Sandstone	28 55
Pollard, Fenton	860728	528700	5111700	80	75	50	34	8	15	0-33 Till 33-80 Sandstone	50 53
Young, Ralph	740817	528701	5112594	55	25	28	38	9	1	0-35 Fractured sandstone 35-55 Sandstone	
Clements, Robert	790611	528800	5111700	65	75	24	38	7	8	0-35 Till 35-65 Sandstone	65 68
Young, Ralph	770831	528800	5112900	80	55	48	34	7	4	0-30 Till 30-80 Sandstone	48 80
Sefarin, George	730528	528903	5112694	80	75	48	24	9	1	0-20 Fractured clay 20-80 Sandstone	
McGowan, Malcolm	810615	529050	5112400	145	50	75	109	10	5		115 145
McGowan, Malcolm	791128	529500	5112400	75	100		28	5	10	0-21 Till 21-75 Claysand, sandstone	40 43 72 75
MacDonald, Hugh	790425	529800	5113400	55	25	24	32	6	8	0-29 Till 29-50 Sandstone	
Watson, J.	790615	529800	5113800	65	25	32	23	7	8	0-18 Till 18-65 Sandstone	30 33 62 65
MacKenzie, Roderick	710604	529801	5112793	60	40	39	25	5	10		
MacKenzie, Donnie	730425	529870	5112300	100	75	50	30	8	10	0-26 Clay till, fractured clay sandstone 26-100 Fractured sandstone, clay, sandstone	
MacKenzie, Ken	801028	529900	5112300	75	25	45	33	10	5	0-75 Claysand sandstone	45 48 72 75
MacLeod, Waldo	720609	529902	5112793	55	55	28	22	15		0-16 Soft clay till 16-55 Sandstone	
Lenihan, David	710809	530000	5113000	55		27	20	20			
		Averages		90		37	35	11			

APPENDIX II

WATER QUALITY DATA

APPENDIX II
Water Quality Analyses
MONTAGUE

Name&Date		Easting/Northing	Parameters Ca	Mg	Na	K	Hard.	Alk.	Cl	SO4	P	NO3	pH	Fe (T)	Fe (D)	Mn	Cd	Cu	Cr	Ni	Pb	Zn
Annie's Rest.	850717	526950/5112450	48.1	21.72	27.3	2.82	210.1	159	90		0.16	2.4	7.5	< 0.1	< 0.1	< 0.02		0.02			< 0.1	0.24
Donna Baldwin	770225	527800/5111900	45.0	19.00	12.0	4.60	191.0	136	17		0.07	10.0	8.4		< 0.1	< 0.02		0.02			< 0.1	0.10
Jack Beck	850612		59.8	11.00	7.0	3.39	206.5	257	17		0.09	1.2	7.4	< 0.1	< 0.1	< 0.02		0.09			< 0.1	4.67
Art Campbell	820819	52820u/5099500																				
Shirley Campbell	861107	527000/5112800	45.6	22.30	17.9	2.08	207.1	186	32		0.06	1.8	7.7	< 0.1	< 0.1	0.20		0.04			< 0.1	0.61
Art Clements	770511		36.0	18.50	9.0	1.75	164.0	110	29		0.10	2.8	8.5		< 0.1	< 0.02		0.28			< 0.1	0.10
Kenny Clements	770511		50.0	23.75	15.0	2.36	222.0	136	55		0.06	6.0	8.2		< 0.1	< 0.02		0.20			< 0.1	0.14
Kenny Clements	770523		53.0	26.00	21.0	4.80	239.0	167	58		0.06	6.0	8.3		< 0.1	< 0.02		< 0.02			< 0.1	0.64
Stan Collings	800722	527400/5111500	40.0	17.00	92.0	2.60	170.0	215	160	11	0.12	2.6	7.9	0.2		< 0.02		2.60			< 0.1	0.80
Stan Collings	830531	527400/5111500	56.6	26.30	57.9	2.14	248.0	88	90	10	0.10	4.7	8.0	0.3	< 0.1	< 0.02		0.08			< 0.1	0.25
Stan Collings	840606	527400/5111500	78.8	19.63	60.3	2.06	278.8	174	80		0.11	1.0	8.0	0.2	< 0.1	0.05		0.07			< 0.1	0.63
Stan Collings	860613	527400/5111500	36.9	17.66	82.0	2.46	165.5	185	130		0.11	1.4	7.5	< 0.1	< 0.1	< 0.02		0.36			< 0.1	0.29
Conean Ins.	861210		15.7	7.06	20.4	2.21	71.7	56	38		0.06	0.4	6.0	0.2	< 0.1	< 0.02		0.25			< 0.1	2.05
Linda Crawford	860709	527500/5111600	46.3	21.66	52.0	3.07	205.7	147	110		0.13	1.5	7.4	< 0.1	< 0.1	0.04		0.15			< 0.1	0.36
Frank Greene	821118	527500/5112500	42.0	7.74	18.7	2.72		176	50	6	0.06	1.7	8.2	0.1	< 0.1	< 0.02	< 0.02	0.02	< 0.05	< 0.05	< 0.1	0.21
Doug Herring	770511		43.0	21.00	12.0	2.50	194.0	125	50		0.06	4.5	8.4		< 0.1	0.02		0.35			< 0.1	0.12
Imperial Oil	821118	527500/5112400	41.0	16.15	16.5	2.37		152	45	6	0.04	1.4	8.1	0.2	< 0.1	< 0.02	< 0.02	0.09	< 0.05	< 0.05	< 0.1	0.65
Jeanie Jackson	861119	528250/5111700	51.8	28.30	69.0	3.02	246.7	188	110		0.06	3.8	7.8	< 0.1	< 0.1	< 0.02		0.14			< 0.1	0.42
Richard Jackson	770210	527650/5111800	50.0	21.50	14.5	3.10	205.0	121	40	13	0.06	6.5	8.1	0.0	< 0.1	0.02		0.02			< 0.1	0.10
Everett Kay	850619	527000/5113400	43.8	22.39	16.0	2.70	202.5	203	36		0.10	2.4	8.9	< 0.1	< 0.1	< 0.02		0.15			< 0.1	0.51
Judy King	770516		26.0	14.75	5.5	1.40		94	15		0.14	2.3	8.1		< 0.1	< 0.02		< 0.02			< 0.1	0.12
Langley's	850715	527350/5113250	23.2	11.70	4.8		106.0	104	7	0.3		0.7	7.5	0.0								
Langley's	860630	527350/5113250	21.7	11.00	33.6		99.6	94	7	3.2		0.7	8.1	0.1		0.20						
Langley's	750918	527350/5113250	20.0	10.50	5.5	1.30	101.0	69	14			7.8	8.0			< 0.02						
Ethel MacDonald	770210	527650/5111800	50.0	20.50	7.1	4.70	200.0	133	14	7	0.06	9.0	8.1	0.0	< 0.1	0.02		< 0.02			< 0.1	0.15
John MacLeod	800722		62.0	37.50	19.0	2.40	309.0	269	65	11	0.10	2.7	7.9	< 0.1		< 0.02		0.05			< 0.1	0.62
John MacLeod	850620		56.6	33.14	30.6	2.47	278.5	199	120		0.06	2.0	7.5	< 0.1	< 0.1	< 0.02		0.11			< 0.1	0.36
Ken MacLeod	850626	527000/5113500	42.8	18.82	10.7	1.93	185.8	185	28		0.06	2.4	7.0	< 0.1	< 0.1	0.10		0.08			< 0.1	0.72
John McLean	830531	527400/5111600	5.4	1.88	327.0	1.73	21.0	260	190	13	0.06	0.9	7.7	0.3	< 0.1	< 0.02		0.04			< 0.1	0.09
Gary MacSwain	840606	530750/5100350	60.3	13.93	6.2	1.55	208.9	107	13		0.15	1.5	8.2	< 0.1	< 0.1	0.05		0.02			< 0.1	0.46
Montague Dairy	830211	427040/5112090	56.7	6.54	232.0	9.50		193	250	26	0.06	2.1	8.0	< 0.1	< 0.1	0.10		0.03			< 0.1	0.14
Montague Dairy	860612	427040/5112090	19.1	10.12	5.1	2.30	90.1	93	6		0.06	0.5	7.7	< 0.1	< 0.1	< 0.02		0.02			< 0.1	0.33

Name&Date		Easting/Northing	Ca	Mg	Na	K	Hard.	Alk.	Cl	SO4	P	NO3	pH	Fe (T)	Fe (D)	Mn	Cd	Cu	Cr	Ni	Pb	Zn
M. Lions Club	821118	527500/5112400	31.0	12.29	12.3	2.19		136	36	7	0.04	1.2	8.1	0.1	<0.1	<0.02	<0.02	0.06	<0.05	<0.05	<0.1	0.31
John Morse	821118	527500/5112600	23.0	8.30	4.8	1.72		118	15	2	0.02	1.0	8.1	0.1	<0.1	<0.02	<0.02	0.04	<0.05	<0.05	<0.1	0.05
Donald Nelson	860319	526200/5112500	31.8	11.63	8.8	2.24	128.7	139	19		0.09	4.3	7.4	<0.1	<0.1	<0.02		0.06			<0.1	0.80
Carl Reynolds	830210		126.9	38.40	451.0	30.40		425	1000	18	0.04	1.4	7.3	4.1	<0.1	21.90		0.06			<0.1	0.10
John Rowe	800722	527400/5111400	40.0	17.50	14.5	2.00	172.0	198	42	11	0.09	2.6	8.5	0.1		<0.02		0.06			<0.1	1.15
John Rowe	830531	527400/5111400	77.4	46.80	28.2	2.37	382.0	223	70	7	0.20	<0.2	8.0	0.2	<0.1	<0.02		0.07			<0.1	0.55
John Rowe	850820	527400/5111400	5.9	1.90	312.0	0.90	23.3	253	260		0.08	<0.2	7.4	<0.1	<0.1	<0.02		0.02			<0.1	0.36
John Rowe	830531	527400/5111500	72.8	49.30	27.5	2.15	380.0	211	70	7	0.10	1.7	7.9	<0.1	<0.1	<0.02		0.09			<0.1	0.57
John Rowe	850820	527400/5111500	51.8	36.10	28.0	2.14	278.4	198	100		0.06	1.9	7.7	<0.1	<0.1	<0.02		0.06			<0.1	0.17
John Rowe	860613	527400/5111500	62.1	30.34	41.0	2.78	281.3	188	160		0.13	1.1	7.4	<0.1	<0.1	<0.02		0.12			<0.1	0.74
Blair Sorrey	850807	527800/5112100	40.5	21.95	18.5	2.65	192.0	149	70		0.10	2.8	7.7	<0.1	<0.1	0.02		0.02			<0.1	0.19
St. Mary's	800722	527400/5111600	48.0	23.00	80.0	3.25	214.0	207	165	12	0.07	3.0	8.3	0.1		<0.02		0.10			<0.1	0.40
St. Mary's	820315	527400/5111600	56.0	27.20	57.0	3.20	252.0	217	100	21	0.08	3.5	7.5	0.1	<0.1	<0.02		0.06			<0.1	0.45
St. Mary's	830531	527400/5111600	73.5	36.90	67.5	2.80	333.0	241	100	6	0.08	0.6	7.9	<0.1	<0.1	<0.02		0.20			<0.1	0.56
St. Mary's	840606	527400/5111600	85.2	31.50	75.8	2.68	342.7	207	140		0.06	2.3	8.1	<0.1	<0.1	0.04		0.05			<0.1	0.08
St. Mary's	850820	527400/5111600	51.7	28.57	49.0	3.90	247.1	188	120		0.10	1.9	7.8	<0.1	<0.1	<0.02		0.06			<0.1	0.14
St. Mary's	860613	527400/5111600	50.6	24.54	81.0	2.89	226.1	197	170		0.10	1.8	7.8	<0.1	<0.1	<0.02		0.06			<0.1	0.33
Texaco	840606	527800/5109800	62.7	18.54	14.0	1.50	233.3	107	80		0.06	<0.2	7.9	<0.1	<0.1	0.03		<0.02			<0.1	0.13
E. Vanlderstine	821118	527500/5112500	37.0	13.26	14.9	2.22		169	25	9	0.04	2.3	8.3	0.2	<0.1	<0.02	<0.02	0.07	<0.05	<0.05	<0.1	0.66
W. Vanlderstine (old)	821118	527500/5112500	34.0	14.61	15.6	2.36		147	41	7	0.04	1.8	8.3	0.3	<0.1	0.04	<0.02	0.06	<0.05	<0.05	<0.1	0.48
W. Vanlderstine (new	821118	527500/5112500	32.0	11.50	15.5	2.31		141	43	7	0.02	1.7	8.0	0.1	<0.1	0.02	<0.02	0.03	<0.05	<0.05	<0.1	0.69
Mr. Vanowerkerk	840606	527350/5111600	86.7	35.90	23.3	2.24	364.7	198	50		0.08	2.0	7.9	<0.1	<0.1	0.03		0.02			<0.1	0.15
Mr. Vanowerkerk	860613	527350/5111600	48.9	25.89	29.8	2.52	229.4	186	90		0.11	1.6	7.5	<0.1	<0.1	<0.02		0.02			<0.1	0.33
Ben Weatherbie	770210	527650/5111800	47.0	19.00	7.3	3.40	200.0	121	16	8	0.06	12.0	8.0	0.0	<0.1	0.02		0.05			<0.1	0.15
George Webster	860219	526250/5111750	65.1	31.40	149.0	4.69	341.0	141	400		0.06	3.2	7.5	0.4	<0.1	<0.02		0.16			<0.1	0.32
Williams Ent.	860613	527500/5112600	26.4	11.85	4.6	1.48	115.6	102	9	6	0.06	1.2	7.8	<0.1	<0.1	<0.02	<0.02	<0.02	<0.05	<0.05	<0.1	0.45
G. Yorston	800723	527400/5111500	47.0	24.00	16.0	1.95	216.0	201	50	10	0.13	1.9	8.3	0.1		<0.02		<0.02			<0.1	0.20
S.Kings Service C.	800723	527400/5111500	45.0	21.50	19.0	4.40	201.0	193	200	11	0.10	2.7	8.2	0.2		<0.02		0.06			<0.1	0.40
S.Kings Service C.	830531	527400/5111500	101.9	53.20	50.8	6.96	469.0	245	150	6	0.14	1.7	7.5	<0.1	<0.1	<0.02		0.09			<0.1	0.19
S.Kings Service C.	840606	527400/5111500	101.4	40.40	66.3	8.10	420.0	212	150		0.11	3.0	7.8	<0.1	<0.1	0.04		0.09			<0.1	0.17
S.Kings Service C.	841212	527400/5111500	37.6	20.84	17.1	4.20	180.0	202	70		0.09	2.9	7.7	<0.1	<0.1	0.04		0.02			<0.1	0.02
S.Kings Service C.	850717	527400/5111500	52.6	22.53	10.8	1.83	224.8	153	70		0.18	2.6	7.7	<0.1	<0.1	<0.02		0.03			<0.1	0.36
S.Kings Service C.	850820	527400/5111500	49.1	18.96	93.0	2.66	201.3	220	160		0.06	2.5	8.2	<0.1	<0.1	<0.02		0.56			<0.1	0.26
S.Kings Service C.	860613	527400/5111500	54.5	24.67	45.0	4.10	238.1	186	110		0.12	1.4	7.6	<0.1	<0.1	<0.02		0.07			<0.1	0.17
S.Kings Service C.	870225	527400/5111500	41.4	21.87	25.4	2.87	194.3	183	80		0.10	2.1	7.8	<0.1	<0.1	<0.02		<0.02			<0.1	0.47

Name&Date		Easting/Northing	Ca	Mg	Na	K	Hard.	Alk.	Cl	SO4	P	NO3	pH	Fe (T)	Fe (D)	Mn	Cd	Cu	Cr	Ni	Pb	Zn
S.Kings Service C.	870826	527400/5111500	64.0	33.93	7.4	3.57	300.9	211	130		0.18	2.1	7.6	< 0.1	< 0.1	0.06		0.03			< 0.1	0.72
Glenmar Trailer	841012	527420/5113380	28.3	15.66	10.7	1.93	135.4	136	21		0.14	1.7	8.0	< 0.1	< 0.1	< 0.02		0.04			< 0.1	0.06
Glenmar Trailer	850227	527420/5113380	31.3	14.60	8.9	1.90	140.5	139	19		0.10	1.6	7.8	< 0.1	< 0.1	0.02		0.06			< 0.1	1.34
Hospital	700902	526560/5112640	48.0				82.0	54	13	2.6		2.8	7.9									
Hospital	810722	526560/5112640	4.0	0.40	64.0	0.30	12.0	111	15	11	0.10	0.7	8.0	0.1	< 0.1	< 0.02		0.15			< 0.1	0.35
Hospital	840411	526560/5112640	5.2	0.45	66.2	0.62	16.1	119	18		0.12	1.1	8.3	0.2	< 0.1	< 0.02		0.03			< 0.1	0.72
Hospital	841012	526560/5112640	0.8	0.22	74.0	0.79	2.6	113	22		0.20	0.7	7.7	< 0.1	< 0.1	< 0.02		0.02			< 0.1	0.49
Hospital (#1)	850424	526560/5112640	18.0	6.93	5.9	1.09	74.0	99	15		0.16	0.5	7.6	< 0.1	< 0.1	< 0.02		0.05			< 0.1	0.23
Hospital (#2)	850424	526560/5112640	16.1	6.86	11.8	1.06	69.1	96	24		0.16	1.0	7.8	< 0.1	< 0.1	< 0.02		0.03			< 0.1	0.28
Hospital (#2)	850827	526560/5112640	27.6	11.42	12.3	1.45	117.1	103	28		0.12	0.7	7.6	< 0.1	< 0.1	< 0.02		0.03			< 0.1	0.62
Hospital	860130	526560/5112640	2.0	0.26	67.0	0.51	6.8	106	21		0.14	7.0	8.0	0.2	< 0.1	< 0.02		0.07			< 0.1	0.32
Hospital (#1&2)	860611	526560/5112640	1.1	0.34	68.0	0.48	4.7	97	23		0.13	0.8	7.8	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.20
Hospital (#1)	860613	526560/5112640	5.4	0.28	73.0	0.96	15.4	110	27		0.06	1.1	7.5	< 0.1	< 0.1	< 0.02		0.02			< 0.1	0.40
Hospital (#2)	860613	526560/5112640	4.1	0.33	65.0	0.36	12.5	91	22		0.14	0.9	7.7	< 0.1	< 0.1	< 0.02		0.05			< 0.1	0.43
Hospital	880203	526560/5112640	25.2	12.32	8.4	1.41	113.9	96	27		0.18	1.1	8.1	< 0.1	< 0.1	< 0.02		0.04			< 0.1	< 0.02
Elementary Sch.	841105	526550/5112360	33.3	13.56	5.8	1.21	140.3	120	17		0.10	1.7	7.8	< 0.1	< 0.1	< 0.02		0.12			< 0.1	0.72
Elementary Sch.	860130	526550/5112360	22.6	12.86	5.8	1.24	109.8	106	16		0.10	2.3	8.0	< 0.1	< 0.1	< 0.02		0.38			< 0.1	0.13
Elementary Sch.	860127	526550/5112360	23.3	11.62	6.0	1.29	106.3	119	15		0.11	2.3	7.8	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.03
Jr High School	811111	526860/5112470	34.0	10.00	8.0	1.60		91	70	13	0.06	1.9	8.0	0.1	< 0.1	< 0.02		< 0.02			< 0.1	0.05
Jr High School	841105	526860/5112470	46.2	20.57	11.6	1.75	201.3	160	50		0.11	2.2	7.9	< 0.1	< 0.1	< 0.02		0.03			< 0.1	0.71
Jr High School	860130	526860/5112470	40.4	18.70	12.0	1.86	179.0	141	45		0.12	2.2	8.0	0.2	< 0.1	0.14		0.10			< 0.1	0.44
Jr High School	860127	526860/5112470	36.9	20.58	15.0	2.19	177.1	160	50		0.16	2.1	7.9	< 0.1	< 0.1	< 0.02		0.20			< 0.1	0.06
Regional High	841105	526860/5112390	33.2	14.12	9.0	1.44	141.9	107	34		0.11	1.4	7.9	< 0.1	< 0.1	< 0.02		0.03			< 0.1	0.43
Regional High	860130	526860/5112390	23.2	12.96	8.7	1.35	111.6	94	31		0.12	2.5	7.9	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.13
Regional High	860127	526860/5112390	24.0	13.15	8.9	1.49	114.3	106	34		0.16	1.6	7.9	< 0.1	< 0.1	< 0.02		0.04			< 0.1	0.04
Riverview Manor	810722	527880/5111960	40.0	14.80	10.0	1.80	161.0	133	36	13	0.06	7.0	8.0	0.1	< 0.1	< 0.02		0.16			< 0.1	0.39
Riverview Manor	841012	527880/5111960	41.5	20.34	12.1	1.77	187.9	141	37		0.14	8.0	8.1	< 0.1	< 0.1	< 0.02		0.16			< 0.1	0.25
Riverview Manor	860319	527880/5111960	36.6	14.23	12.4	2.21	150.7	137	38		0.09	9.0	7.7	< 0.1	< 0.1	< 0.02		0.13			< 0.1	0.38
Sr Cit(Wood la)	810722	527480/5111690	14.0	3.20	110.0	0.95	48.0	120	16	6	0.12	1.5	8.1	0.2	< 0.1	0.20		0.25			< 0.1	0.45
Sr Cit(Wood la)	841012	527480/5111690	0.9	0.85	85.0	0.69	6.0	157	18		0.16	1.8	8.1	< 0.1	< 0.1	< 0.02		0.12			< 0.1	0.06
Sr Cit(Wood la)	860129	527480/5111690	30.5	17.89	8.7	1.64	150.5	163	19		0.18	1.8	8.1	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.33
Sr. Citizens	780210		34.0	16.20	5.0	1.40	168.0	138	13		0.06	2.1	8.0		< 0.1	< 0.02		< 0.02			< 0.1	0.06
Sr Cit.(Campb.)	810722	527420/5112450	30.0	11.60	6.0	1.45	123.0	169	24	7	0.06	2.1	8.1	< 0.1	< 0.1	< 0.02		0.30			< 0.1	0.30
Sr Cit.(Campb.)	841105	527420/5112450	61.4	25.06	13.5	1.80	257.9	247	37		0.12	3.1	7.9	< 0.1	< 0.1	< 0.02		0.02			< 0.1	0.82
Sr. Cit. A (C)	841206	526600/5112600	26.2	25.59	15.8	1.52	171.2	152	70		0.06	2.1	7.9	< 0.1	< 0.1	< 0.02		0.07			< 0.1	0.16

Name&Date		Easting/Northing	Ca	Mg	Na	K	Hard.	Alk.	Cl	SO4	P	NO3	pH	Fe (T)	Fe (D)	Mn	Cd	Cu	Cr	Ni	Pb	Zn
Sr. Clt. A (H)	841206	526600/5112600	25.4	24.59	14.7	1.43	165.5	150	80		0.06	2.2	7.9	< 0.1	< 0.1	< 0.02		0.10			< 0.1	0.44
Sr. Clt. A	850626	526600/5112600	59.1	28.69	22.9	3.49	266.0	148	150		0.09	1.6	7.8	< 0.1	< 0.1	0.02		< 0.02			< 0.1	0.08
Sr. Clt. A	860316	526600/5112600	48.3	18.75	22.4	3.07	198.7	138	120		0.10	1.8	7.6	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.49
Sr. Clt. B	810722	526570/5112570	46.0	16.80	10.0	2.80	184.0	148	90	12	0.06	1.9	8.0	0.1	< 0.1	0.21		0.35			< 0.1	0.35
Sr. Clt. B	841012	526570/5112570	50.6	26.51	30.9	2.67	235.9	157	110		0.13	1.8	8.0	0.4	< 0.1	< 0.02		0.36			< 0.1	0.17
Sr. Clt. B	841128	526570/5112570	52.5	27.97	28.9	2.42	247.2	160	110		0.10	1.8	8.0	< 0.1	< 0.1	< 0.02		0.02			< 0.1	0.51
Sr. Clt. B	841206	526570/5112570	36.9	20.92	24.0	1.84	178.5	166	110		0.09	2.0	7.9	< 0.1	< 0.1	< 0.02		0.15			< 0.1	0.05
Sr. Clt. B	850626	526570/5112570	42.5	21.51	96.0	5.78	195.5							< 0.1	< 0.1	< 0.02		0.03			< 0.1	0.39
Sr. Clt. B	860319	526570/5112570	43.8	17.86	35.4	3.07	183.6	144	120		0.10	2.8	7.7	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.36
Sr. Clt. C	850626	526570/5112570	58.5	27.06	69.0	5.64	258.3	149	190		0.10	1.5	7.5	< 0.1	< 0.1	< 0.02		0.04			< 0.1	0.42
Sr. Clt. C	860319	526570/5112570	45.5	18.53	35.6	3.78	190.2	146	130		0.10	1.5	7.8	< 0.1	< 0.1	< 0.02		0.11			< 0.1	0.09
Sr. Clt. D (C)	841206	526600/5112550	40.4	23.24	25.5	2.13	198.8	164	90		0.09	2.0	7.7	< 0.1	< 0.1	< 0.02		0.10			< 0.1	0.08
Sr. Clt. D (H)	841206	526600/5112550	41.9	23.64	26.0	2.21	202.5	162	100		0.10	2.0	7.7	< 0.1	< 0.1	< 0.02		0.20			< 0.1	0.25
Sr. Clt. D	850626	526600/5112550	56.2	24.67	61.0	5.08	243.2	149	190		0.10	1.5	7.6	0.3	< 0.1	< 0.02		0.10			< 0.1	0.71
Sr. Clt. D	860319	526600/5112550	48.3	18.59	37.5	4.00	198.5	154	130		0.10	1.8	7.8	< 0.1	< 0.1	< 0.02		0.11			< 0.1	0.79
Sr. Clt. E	841205		10.2	1.52	90.0	0.78	35.0	166	18		0.15	1.7	8.0	< 0.1	< 0.1	< 0.02		0.03			< 0.1	2.00
Sr. Clt. E	850612		41.2	18.63	6.6	1.77	181.6	158	17		0.10	1.7	7.7	< 0.1	< 0.1	< 0.02		0.10			< 0.1	1.21
Sr. Clt. F	850612	527421/5112455	54.4	25.26	14.9	2.15	241.1	211	36		0.09	3.2	7.8	< 0.1	< 0.1	< 0.02		0.05			< 0.1	0.73
Sr. Clt. F	860319	527421/5112455	27.0	9.23	5.1	1.71	106.6	121	11		0.06	1.0	7.7	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.67
Sr. Clt. G (C)	841212	527420/5112450	20.1	9.02	3.7	1.24	87.6	125	7		0.06	1.1	8.3	< 0.1	< 0.1	< 0.02		0.04			< 0.1	0.08
Sr. Clt. G (H)	841212	527420/5112450	14.1	12.50	4.2	1.42	87.3	119	7		0.06	0.8	8.0	< 0.1	< 0.1	< 0.02		0.06			< 0.1	0.27
Sr. Clt. G	850612	527420/5112450	50.2	24.34	8.3	2.26	225.9	116	8		0.04	0.7	7.7	< 0.1	< 0.1	< 0.02		0.05			< 0.1	0.13
Sr. Clt. G	860319	527420/5112450	23.7	8.06	4.2	1.77	93.2	117	9		0.05	0.8	7.7	< 0.1	< 0.1	0.03		0.09			< 0.1	0.35
Sr. Clt. H	850918	527880/5111960	42.6	21.64	15.4	1.88	196.2	154	45		0.04	7.0	7.8	< 0.1	< 0.1	< 0.02		0.02			< 0.1	0.37
Sr. Clt. H	860319	527880/5111960	39.1	14.91	15.5	2.49	159.5	155	45		0.06	7.0	7.7	< 0.1	< 0.1	< 0.02		0.10			< 0.1	0.22
Sr. Clt. J	850918	527880/5111960	41.6	22.40	10.3	1.87	196.7	161	33		0.06	7.0	7.6	< 0.1	< 0.1	< 0.02		0.18			< 0.1	0.27
Sr. Clt. J	860319	527880/5111960	36.3	14.75	10.2	2.07	152.0	152	33		0.06	8.0	7.8	< 0.1	< 0.1	< 0.02		0.12			< 0.1	0.27
		CDWS							250	500		10.0	6.5-8.5	0.3		0.05	0.005	1.00	0.05		0.05	5.00